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AVAILABILITY, PRODUCTION AND DISTRIBUTION OF CLEAN-BURNING FUELS

HEARING

BEFORE THE

SUBCOMMITTEE ON MINERAL RESOURCES DEVELOPMENT AND PRODUCTION

OF THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON THE

AVAILABILITY, PRODUCTION AND DISTRIBUTION OF CLEAN-BURNING FUELS

ALBUQUERQUE, NM, MAY 25, 1989

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CONTENTS

STATEMENTS

Bartlit, Dr. John R., New Mexico Citizens for Clean Air and Water 26
Bethel, Dr. Robert, the National Jewish Center for Immunology and Respiratory Medicine 76
Bicknell, Nadyne C., member, Albuquerque City Council 208
Bingaman, Hon. Jeff, U.S. Senator from New Mexico 1
Cannon, James S., energy consultant, New Mexico Energy, Minerals and Natural Resources Department 81
Domenici, Hon. Pete V., U.S. Senator from New Mexico 6
Fouts, Dr. James R., Senior Scientific Advisor to the Director, National Institute of Environmental Health Sciences 41
Garcia, William E., director, Public Affairs Department, U.S. West Communications 180
Holmberg, William C., environmental consultant, Clean Fuels Development Coalition 116
Klimisch, Dr. Richard L., executive director, environmental activities staff, General Motors Corp 163
Lindahl, David M., Director, Office of Alcohol Fuels, Department of Energy 95
Lithgow, Clarence "Porky" chief administrative officer for the city of Albuquerque 7
Lorang, Philip A., Chief, Technical Support Staff, Emission Control Technology Division, Office of Mobile Sources, Environmental Protection Agency 108
Luna, Dr. Robert E., chairman, Technical Assistance Group for Clean Air 8
Peterson, Ray, transit director, city of Las Cruces, NM 239
Sheck, Dr. Ronald C., director, Transportation Programs Division, New Mexico Highway and Transportation Department 191
Spengler, Dr. John D., professor of environmental health, Department of Environmental Science and Physiology, Harvard School of Public Health 54
Yuhnke, Robert E., senior attorney, Environmental Defense Fund 15

APPENDIX

Additional material submitted for the record 265

AVAILABILITY, PRODUCTION AND DISTRIBUTION OF CLEAN-BURNING FUELS

THURSDAY, MAY 25, 1989

U.S. SENATE,
SUBCOMMITTEE ON MINERAL RESOURCES
DEVELOPMENT AND PRODUCTION,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Albuquerque, NM.

The subcommittee met, pursuant to notice, at 8:30 a.m., in the Continuing Education Conference Center, 1634 University Boulevard, N.E., Albuquerque, NM, Hon. Jeff Bingaman presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

Senator BINGAMAN. This is a hearing of the Subcommittee on Mineral Resources Development and Production of the Senate Energy and Natural Resources Committee. I want to express my appreciation to Senator Johnston, chairman of the full committee, for agreeing to schedule this hearing today.

The purpose of the hearing is to receive testimony on the availability, production, and distribution of clean-burning fuels. I hope we can receive testimony that will help the Senate devise strategies to address the growing problem of air pollution.

You may ask why the Senate Energy Committee came to New Mexico; is having a hearing here?

New Mexico is well prepared to meet the challenge of clean air using cleaner burning fuels. We have a talented and active scientific community with the expertise to help. We have abundant reserves of natural gas, one of the clean-burning fossil fuels that will be key to cleaning up our air, and we have the resolve to tackle the air quality problem. We are in a city that forcefully moved to clean its air after the EPA imposed sanctions in 1987 by implementing a new auto emissions control program. A program that, despite early concerns, was put in place with very little public opposition. The industry in New Mexico also deserves credit for leading the nation in investing in scrubbers to reduce harmful fossil fuel emissions. The public clearly accepts the need to take action as evidenced through the hard work and dedication that has lead to this successful "Clean Air Week" here in Albuquerque. That speaks highly of this community and of its priorities and should help Albuquerque serve as a model for the rest of the nation.

There are several issues that we need to pursue today. I think we are going to hear some excellent testimony on several of these issues. Let me just mention two or three.

We will hear today about the need to make automobiles run cleaner. The Clean Air Act reauthorization, which, of course, is before us in Congress concerns New Mexico particularly because of our high altitude situation that we have here in the West. The fact is that the concerns of the West have not, in previous Congresses been given adequate attention.

Obviously, we need to know what we can learn about new technologies, and the use of those new technologies to deal with the problems in cleaning up our air. And we have some good witnesses to talk about that issue.

There is a lot we can do. I think that this hearing will help us to identify additional strategies that we can pursue and some action steps.

A working group has developed the agenda for this summit and for this hearing. I think they have done an excellent job, and I very much appreciate the hard work that has gone into this preparation. Many of those folks were present last evening, and I think this hearing today is an opportunity for us to get some real expert advice on what is happening.

Let me at this point defer to my colleague, Senator Domenici, who is also, of course, a member of the Senate Energy and Natural Resources Committee and very concerned about this issue. I am very pleased that he is here today to participate.

[The prepared statement of Senator Bingaman follows:]

JEFF BINGAMAN
NEW MEXICO

524 HART SENATE OFFICE BLDG
WASHINGTON, DC 20510
(202) 224-5521
IN NEW MEXICO—1-800-443-8658
TDD (202) 224-1792

United States Senate

STATEMENT BY THE HONORABLE JEFF BINGAMAN

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BINGAMAN STRATEGIES

I have some ideas about what strategies we ought to pursue to improve our air quality and I know today's hearing will add to this list.

CLEANER CARS

We will hear today about the need to make automobiles run cleaner. That sounds simple, but consumers won't buy alternative fuel cars because the fuel is not for sale, and companies don't sell the fuel because there's no demand. I have introduced a bill that will address this problem by having the federal government take a lead role in providing an incentive for cleaner burning fuels.

My Clean Air Fuel Conversion Act, which I introduced last week, would require the gradual conversion of federal vehicles to clean-burning, alternative fuels, such as ethanol, methanol, MTBE, compressed natural gas, propane, and electricity which will reduce the carbon monoxide problem. The legislation would require the government to install alternate fuel pumps to serve its own fleet, where there are no commercial pumps available. Also, it would require the government to sell these fuels to the public; again, until there are commercial suppliers. This way, the public can try out these vehicles and create a market that will entice commercial companies to join the enterprise. Also, we now look forward to the contribution of Detroit in this effort. And General Motors has announced it will encourage its customers to use oxygenated fuels in all of its vehicles. They will testify about that effort today.

CLEAN AIR ACT REAUTHORIZATION

The Clean Air Act will be reauthorized during the 101st Congress. I will vigorously push for reauthorization and flexibility for states in the West with special air quality problems. For example, those of us who live in high-altitude communities, like Albuquerque and other New Mexico cities, face special problems because of the combustion process and the geography of our mountain basins. This requires the greater use of clean-burning fuels such as natural gas in industry and power production plus the use of blended fuel in vehicles. I hope the Environmental Protection Agency and the Department of Energy Witnesses can testify to our government's efforts to improve our air quality. And I look forward to the testimony of our scientific panel on the health effects associated with our clean air effort.

INTERDISCIPLINARY STRATEGIES AND NEW TECHNOLOGIES

On the local level, city, county, and state officials need to make transportation and land use planning decisions with clean air in mind. Additionally, we need to give increased attention at the local and national level to new technologies that reduce harmful emissions such as those currently under development for wood stoves, fireplaces, diesel engines and fossil fuels.

We will hear testimony today by the Technical ASSISTANCE [redacted] Group - a group of scientists in our community who have been working on these issues for the past several months. They'll make recommendations for action in the Clean Air area which I'm sure will guide us well.

In summary, we must make our cars and trucks run on cleaner fuels; we must address the special air quality problems of the West; we must use transportation and land-use planning to reduce air pollution; and we must encourage the development and use of innovative techniques to clear the air. Most important, we must realize that the clean air effort and initiative requires everyone -- environmentalists, small businesses, the oil and gas industry, and federal, state and local government -- to work together. We are clearly taking these steps this week.

Before we begin the hearing, I would like to take care of several administrative details. To expedite the hearing, witnesses will testify in panels. When your name is called, please come forward and take a seat. Because of the large number of witnesses appearing today, it will be necessary to limit your oral testimony to 5 minutes. We have a timer here to help keep us on track. Please keep an eye on it as you testify, and please conclude your statement when the red light appears.

The hearing record will remain open for two weeks for additional statements. If anyone would like to submit a statement for the record, please send it to my office here in Albuquerque, our offices in Washington, D.C., or the Senate Energy and Natural Resources Committee in Washington, D.C.

I look forward to hearing the testimony today and want to thank our witnesses for being here.

STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

Senator DOMENICI. Thank you very much, Mr. Chairman.

I join with Senator Bingaman in welcoming all of the distinguished panelists and citizens who are here today on this series of clean air issues. This is not the first hearing on clean air held here in Albuquerque. Looking around I can see some of the witnesses who appeared at the previous hearings. This community has always had a significant interest in federal legislation, and I must say that some of the experts who will testify today have played a lead role in shaping some of the federal legislation and we thank them for that.

I was privileged, Mr. Chairman, to serve on the Environment and Public Works Committee for 12 years. I am not on that committee any more. Many of the New Mexico experts appeared there, and it was in that capacity that some of the hearings were held here in this city.

We are today going to take some very excellent testimony on some very appropriate issues. Congress has been trying to pass a new Clean Air Act since 1981. For the first time I think we are all rather excited because it looks like President Bush is in favor of a new Clean Air Act. He favors an acid rain control statute, and the majority leader in the Senate, Majority Leader Mitchell, is committed to not only in his Environment Committee capacity but in his leader capacity to see it gets done. While I am not on the committee, I do want my friends here who have been in touch with me now and in the past to know that I intend to work with them and what goes on in the committee. In fact, I have met a couple of times with the majority leader, as we look toward both clean air statute and acid rain statute.

Several things have changed, most notably as I indicated, the Bush Administration's active involvement, which I think gives us hope. Likewise, everyone seems to be willing to work together. I think that is new. I particularly welcome these hearings, because we are going to talk about a few issues that are slightly different than the past.

For example, it is only within the past two or three years that alternative fuels have emerged as an important strategy, again, in the containment area.

We are going to hear a panel on interdisciplinary strategies and transportation related strategies that will bring a city like Albuquerque into compliance as far as carbon monoxide.

So I look forward to the testimony and thank you for calling the hearing. We will be delighted to participate here and in the future.

Thank you very much, Mr. Chairman.

Senator BINGAMAN. Thank you. Before I turn to the first panel, I would just like to introduce one present public official and one former public official who are here today in the State of New Mexico. We invited a great many of our public officials to come. We hope others can come as the day progresses. State Representative Bob Hawk, who is here, and played a real leadership role in this, and former Governor Bruce King. We appreciate both of them being here very much. [Applause.]

Our first panel is entitled the "Western Perspective," and will try to focus on some of the aspects of this issue unique to us here in New Mexico. Let me call first on Clarence "Porky" Lithgow, who is the chief administrative officer for the City of Albuquerque.

We are very pleased to have you here, Porky, and please go right ahead.

STATEMENT OF CLARENCE "PORKY" LITHGOW, CHIEF ADMINISTRATIVE OFFICER FOR THE CITY OF ALBUQUERQUE

Mr. LITHGOW. Thank you, Senator and members.

First of all, I would like to congratulate you, Senator Bingaman, for spearheading this Air Quality Summit and for your vision and leadership both local and national on this critical issue. In addition, I would like to thank Senator Domenici for being here, and for the role that he has played in clean air issues for our country and our cities.

We in the Western United States, and more specifically in the Rocky Mountain region, are faced with unique and in some ways more difficult problems than other regions with regard to air quality. We are unique as a result of such static factors as geography, topography and climate conditions and such dynamic factors as our demographics, economy, technology, attitude and life style.

As elected officials setting national policy on this and other issues it is critical that regional differences be recognized and understood, and that policy and legislation be developed that will accommodate those differences without compromising the desired intent and public merit of such law. The key to successful public policy in this regard is flexibility. Each region, and indeed each locale should be given the flexibility to design and implement an air quality program that fits the unique characteristics of the area, while maintaining the integrity of the Clean Air Act. In fact, there should be monetary and other incentives for localities to be creative and innovative in the development and implementation of local programs.

Just as, for example, sanctions are now imposed for nonattainment and noncompliance. However, positive reinforcement has proven to be more successful than negative reinforcement. Incentive should come in the form of the carrot and stick, not just the stick.

Historically, the Federal Government has not always been reasonable in recognizing and making accommodations in programs to account for regional differences. Conversely, many of us in the West have not always been willing to accept federal dictates that require us to change our practices and beliefs. Clearly, however, clean air is an issue we must work together on because in the end the air we breathe does not recognize jurisdictional boundaries or politics.

A few of the regional factors that the members need to consider in formulating the new Clean Air Act include:

Public education—intense effort needs to be placed on educating the public as to the benefits of the various programs designed to improve air quality. The public is extremely distrustful and afraid of programs they do not understand or see no need for. Their attitude is particularly prevalent in regions that have not had a long history of air quality problems and where there may not be an awareness that a problem exists.

Conversely, when the air and water does show signs of degradation, a populous used to a pristine and clean environment will be more outraged than those with less of a compatible experience.

Geography/topography and climate—these factors are of particular concern for the Rocky Mountain region where the altitudes of several major metropolitan areas are over one mile high. Scientists, mechanics and the driving public realize, be it from different perspectives, what the ramifications altitude has on air quality and the performance of vehicles. Any mandates regarding oxygenated fuels should take altitude into consideration.

Distance is another factor. The population of the West is not as dense and therefore, vehicle miles traveled is greater than in more populated Eastern cities. Our cities also tend to be built in valleys that are extremely susceptible to air inversions when coupled with the prevalent winter climatic conditions.

Other factors that need to be considered include the relative age of our vehicles, the limitations on usage of mass transit, market and political constraints on oxygenated fuels, land development patterns and costs.

Mr. Chairman, members, in conclusion I am pleased that the committee scheduled this hearing and for the opportunity to present this testimony today. Mayor Schultz' administration has worked with Senator Bingaman on the implementation of this Clean Air Summit. We thank you for that opportunity and look forward to further endeavors. We wish you well in your quest to develop comprehensive national clean air legislation. The City of Albuquerque will do all it can to assist.

Thank you.

Senator **Bingaman**. Thank you very much, Porky. We appreciate that testimony and appreciate the city's very aggressive efforts in this regard.

Our second witness is Dr. Robert Luna, who is the chairman of the Technical Advisory Group for Clean Air here in Albuquerque. Let me just say that Bob and the Technical Advisory Group has worked very hard over many months to come up with a report and recommend some ways that we can not only improve our situation here in Albuquerque but nationally. So I very much appreciate your hard work and appreciate you being here to tell us about it.

STATEMENT OF DR. ROBERT E. LUNA, CHAIRMAN, TECHNICAL ASSISTANCE GROUP FOR CLEAN AIR

Dr. **Luna**. Thank you very much, Senators. It is a pleasure to be here to address you, and I hope we can be of some additional service to the committee in the future.

My testimony today is intended to present the results of the TAG evaluation and some of the actions relating to potential activities proposed for the Sandia National Laboratories and other research and administration projects contained in your strategy.

I would like to call your attention to the TAG report, which is included in my testimony, to provide some of the detail that I do not have time to cover in this presentation. Copies of the TAG report, by the way, are available at the front desk for people who want to look at it.

There are three principal results that were developed by TAG during the period of our activities. The first is a primer on Albuquerque air quality problems that we developed in order to support the Clean Air Summit. This primer was handed out with the registration packets and contains our view of the principal features of the Albuquerque air quality problem. Some of the proposed solutions and what we expect they might produce for Albuquerque.

In addition, there is a section which relates to an even larger scale view of pollution in general and a few technical papers that we think would be of interest and illuminating some of the topics involved.

The second principal result that came out of the TAG activities was an evaluation of 13 ideas that were put forward in your strategy document for work that the laboratories and other technical organizations might do in order to improve or understand the air quality issues within the City of Albuquerque.

Briefly, I'd like to cover one or two of those. As I indicated, there are 13, which we collected into a set of about 9, and some of them might be of greater interest than others.

One of the items that I think is of interest is some work follows previous work done by Sandia Laboratories in source apportionment in which we attempted to define what fraction of the visibility problem and what fraction of the CO problem was due to fireplaces or woodburning and mobile sources. We believe that work was instrumental in understanding the importance of fireplaces to Albuquerque's pollution problem in the wintertime. We believe that perhaps some additional work needs to be done under truly episodic conditions in order to get a more detailed understanding of the fuel impact of woodburning emissions under worst-case conditions, so we understand exactly what level control we might need on woodburning.

I would also call your attention to the item relating to traffic pattern studies. One of the things that I think is extremely important in understanding how to control air quality problems in Albuquerque is an understanding of where the problem comes from. One of the things that is very difficult to put a handle on is how much of the problem is due to commuters and people who live or are coming from outside our political boundaries and our airshed. There is a need I think to develop some technology on how to put numbers on the commuter component of pollution. I think that we have developed a proposal or an idea how to get a State, county city, initiative going to be able to count vehicles; understand how vehicles come across the boundaries of the Bernalillo County; and how to quantify the amount of pollutants they produce.

With that number we can understand what kind of controls we need to have within the county and what kind of controls subdivisions outside the county current control area might be appropriate.

I would call attention also to the radar gun concept, which is one of the items that was discussed. There was an idea that there was a technology that could be used in place of vehicle maintenance programs. We looked at this technology, and we find it very promising but not as a replacement for inspection and maintenance. In fact, we would suggest that it is a significant component of the third result of our activity which we developed a proposal for a year-round oxygenated fuels demonstration test, in which we would try to put some reasonable certainty on the benefits that oxygen fuels might produce if used in a year-round mode.

It is clear that oxygenated fuels work for older vehicles in the wintertime to control CO. It has been put forward by some researchers that it might be an effective way of helping to control oxygenates in the summertime when combined with correctly blended fuel that minimizes other photochemical materials.

We think that the technology developed by Professor Stedman in Colorado, which is the diagnostic device that we have discovered and have looked into, can be an integral part of this program to allow you to link the emissions and the clean air standards to get an idea of whether or not the computer projected improvements that can come from oxy fuels can, in fact, deliver the changed advocated standards and the concentrations that are projected. The Stedman technique, which is demonstrated outside in the parking lot today, is a way of perhaps confirming the progress toward achieving the controls that oxygenated fuels present.

In closing, I would point out that we are very, very willing to continue to serve as a technical assessment or assistance group to you in understanding some of the technical aspects of pollution and helping you with some of the ideas. I would also point out that our committee did not in any way look at the question of the most efficient source of control, which is in our view getting people out of vehicles, getting people not to burn in their fireplaces, because we believe that is, in fact, a social, political and economic issue; not a technical one. And one which the panel this afternoon and perhaps others who are going to speak to you today have some opinion on that.

Thank you.

[The prepared statement of Dr. Luna follows; the additional material has been retained in subcommittee files:]

Testimony of
Robert E. Luna, PhD
to the Field Hearing of the
Subcommittee on Mineral
Resources Development
U. S. Senate Energy Committee
May 25, 1989

Good morning, my name is Robert E. Luna. I am representing the Technical assistance Group that was founded to support Senator Bingaman's Strategy for Clean Air. I served for 10 years on the Albuquerque/Bernalillo County Air Quality Control Board and have been involved technically in air pollution problems, atmospheric transport and diffusion and other issues related to safety/risk assessment. I am employed at Sandia National Laboratories in Albuquerque, New Mexico as Supervisor of the Transportation Risk Assessment and System Analysis Division. My organization contains a project group that is involved with atmospheric sampling and characterization of atmospheric aerosols. This group was involved in earlier measurement programs that characterized the sources of CO and fine particulate in Albuquerque's air and similar programs in the Dallas area. My testimony today is intended to present the results of the TAG's evaluation and actions relating to the potential activities proposed for the Laboratories and the Research/Demonstration Projects contained in the Strategy. I call your attention to the TAG report which is part of this testimony and particularly to the participants in TAG's activities. I was privileged to work with these individuals during the TAG deliberations.

There were three principal results developed by TAG during the period of our activities. First is a primer on Albuquerque air quality problems that we developed to support the Clean Air Summit. This primer, which is attached to my testimony, provides a brief overview of Albuquerque's air quality problem, some air quality basics, and two reports that we felt might be useful to the participants.

The second principal result is contained in some detail in the TAG report itself and is the evaluation of the thirteen ideas labelled "Laboratory" in the Strategy document provided by Senator Bingaman's office. The 13 ideas were examined for their feasibility and usefulness in understanding or controlling air quality problems or in providing enforcement techniques. We considered the 13 items not as things Sandia might do, but rather as projects that any technical organization might propose to funding agencies. Several of the 13 ideas deserve specific note here:

> Radar Gun Concept - The idea here was that an enforcement tool might be useful that could be pointed at a tailpipe and give an instantaneous reading of the pollutant as being emitted. This concept was judged unlikely, but we found that a U. of Denver Professor, Don Stedman, had developed an instrument that had somewhat similar characteristics. Professor Stedman has used the instrument in Denver and has published some interesting observations on the efficacy of some air quality programs. Professor Stedman is here today and is demonstrating his instrument in the parking lot and will participate in the meetings this afternoon. Sandia has invited Professor Stedman here for this meeting and to present a seminar on Friday at the Laboratory. The capability provided by this instrument allows progress in auto emission control to be monitored in real time. We believe the technique is complementary to the demonstration project that I will discuss later.
>
> Source Apportionment During Pollution Episodes - This effort will require very few resources but would provide some better idea on the importance of vehicle and fireplace sources of CO in times of very high pollutant levels. This information will aid in designation of no-burn nights and in deciding what additional control measures might be appropriate on woodburning equipment.

Traffic Pattern Study - This is also a relatively low budget activity that could be a joint city/county/state/Lab activity which has as its principal result an understanding of how much pollution in the Albuquerque airshed is a result of commuters from outside the airshed. This project could help in convincing other political entities to join Bernalillo County in some control strategies.

Clearinghouse for Documents - To achieve consensus on pollution control methods will require wider understanding of aspects of the air pollution problem. TAG suggests that a reference center could be established to pull together materials on this subject that are understandable to a wide spectrum of audiences and make the materials easily available.

The third principal result is a proposal that the Albuquerque airshed be the location for a combination research/demonstration project relating to year-round use of oxygenated fuels. Some projects of this type are already going forward, but we believe that Albuquerque presents a unique testbed for the concept. We are a high altitude city (combustion processes are affected by altitude), we have only one primary source for oxidants and two for CO, and we are relatively remote from other pollutant sources. Thus, this locale presents an ideal area in which to determine whether (or demonstrate that) oxygenated fuels can reduce oxidants as well as CO emissions. A preliminary description of the project is contained in an attachment to the TAG report. The project, as we envision it, would include several local groups, especially those represented on the TAG. It might also include the technology developed by Professor Stedman to get frequent indications of progress in reducing air pollution. One feature of this project is, of course, that there must be full cooperation of local, state, and federal agencies in enabling legislation/regulation as well as from the oil companies in delivering appropriate product during the course of the study. In particular, it will be necessary to have a no fault agreement with EPA for possible violation of NAAQS's during the course of the study.

To conclude my testimony, I would point out that the TAG has confined itself generally to issues that are largely technical in nature. We have looked at ways to understand how to control, and measure emissions under the assumption that our society is unlikely to change quickly. We have not looked at avoiding vehicle emissions through the use of alternate transportation schemes. We realize that having 40 people on a bus is better than having 40 cars on the road. We also realize that getting 40 people into a bus is not a technical issue. It is a political, social and economic issue that we did not confront, but which should be discussed within the scope of the Clean Air Summit.

Senator BINGAMAN. Thank you very much.

We will have some questions, I am sure, as we go forward here. But let us hear from the other two panel members first. Our next panelist is Robert Yuhnke, who is the senior attorney for the Environmental Defense Fund out of Boulder, Colorado. Bob is a well-recognized national expert on the issue and particularly as it relates to the West. Bob gave an excellent presentation last evening. This will be an abbreviated version and we appreciate your presence.

STATEMENT OF ROBERT E. YUHNKE, SENIOR ATTORNEY, ENVIRONMENTAL DEFENSE FUND

Mr. YUHNKE. Thank you, Mr. Chairman. I particularly want to thank you for bringing this hearing to the West to investigate the needs of the West with regard to clean air.

Senator BINGAMAN. You might just pull that microphone a little closer, if you could. Thank you.

Mr. YUHNKE. Mr. Chairman, there are issues involved with clean air in the West that have not gotten adequate attention in Congress. Your willingness to come to the West and investigate some of those issues represents a major step forward in the ability of the Congress to understand the needs of the West and hopefully to address those.

One of the most important problems that we face in the West is the expected doubling of sulfur dioxide emissions and nitrogen oxide emission from power plants over the next 20 years. EPA has projected that sulfur dioxide emissions will increase by 125 percent, and NO_x emissions by 100 percent as a result of meeting the increased electric power demands of a growing western population. With current regulatory controls in place, those increased emissions will happen, and will result in significant degradation of the western environment.

There are two impacts of concern: One is related to the acid deposition in the vulnerable high country environment of the West, and the other is with regard to visibility impacts.

Currently, we have an existing visibility problem in the West represented by regional haze that has been documented by the Park Service at seven national parks where the Park Service has been measuring visibility with a photographic monitoring network that has been operated for the last 10 years. We can see the magnitude of the current visibility problem by these slides from the Grand Canyon, which typify this problem at all of the of the Western parks.

This first slide is a scene that represents a 10 percentile day. That is a day which represents the clean end of the visibility distribution. The air is this clean or cleaner 10 percent of the time; 50 percent of the time, a median day, the air in the Grand Canyon is approximately this dirty; and 90 percent of the time, or 10 percent of the time, it is this dirty or dirtier. And on a worst-case day visibility is virtually obliterated. The difference between these slides, between the clean condition and the dirty condition, is accounted for almost entirely by sulfates. Approximately 70 percent of that difference is sulfates.

On the median day half the visibility impairment is sulfates. So that sulfates, which are a conversion product of SO_2 in the atmosphere, are the principal culprits in contributing to this regional haze condition.

Now, we asked the Park Service what would happen if these emissions were to double as the EPA projects they will? And the Park Service has done an analysis, which is included as an attachment to our written statement, which indicates that at various parks around the West the clean days would be reduced from nine days per summer to about five per summer. That the median day instead of happening 50 percent of the time, the air would be that dirty or dirtier 65 to 70 percent of the time; and that the dirtiest day, or the tenth percentile dirtiest day, this kind of day, would happen more like 20 to 27 days out of the year or out of the summer instead of only nine. This represents what we think is a clearly unacceptable degradation of the western environment.

This is not just a parks issue. This kind of pollution just does not hang over the boundaries of the national parks. This is a phenomenon that we will experience throughout the West, and it need not happen. There are control technologies. There are policies that could be put in place to address it. We would strongly urge the Congress to consider legislation, as part of the Acid Rain Bill, that would hold the line on these emissions in the West. You are asking the East to cut emissions in half. We do not need that in the West. We do not think that we need to move from an expansive program to immediately reduce emissions. We do think it is important that this level of degradation not be allowed.

Another impact of these large increases in emissions would be with regard to acid deposition. One of the witnesses, who you invited to testify today, who could not attend, was Dr. John Harte. Dr. Harte has been leading a research team at a site near Mexican Cut in central Colorado since 1980. Dr. Harte from the University of California at Berkeley has demonstrated that during the snowmelt period in the late spring in the high country the pollutants captured in the snowpack over the winter are released into the surface waters, into the lakes and streams, and contribute to acidification of those waters. The pH is dropping from a normal of around 6.8 down to about five. This is enough increased acid to have significant impact on aquatic species. It is enough to interfer with the reproduction of trout. And he has demonstrated that in this particular environment it has affected the ability of salamander populations to successfully reproduce.

Since he was not able to be here today, because this is his sampling season for collecting data during the snowmelt period, he asked me to present his testimony to you. I would like to read one sentence from his statement. He says, "If present levels of pollution emissions continue in the Western United States, then over time the episodic acidification phenomenon observed at snowmelt will last longer, and even mid-summer acid levels may reach the point where they threaten other forms of life besides the salamanders."

Senator, if we allow current level pollution to double, as EPA projects, then it is clear that this problem is going to become much worse. We ask you to seriously consider legislation that would hold the line on these emissions in the West.

Thank you.

[The prepared statement of Mr. Yuhnke follows; the additional material has been retained in subcommittee files:]

TO THE SENATE COMMITTEE

ON ENERGY AND NATURAL RESOURCES

EPA PROJECTS DOUBLING OF SO_2 AND NO_x EMISSIONS IN THE WEST BY 2010. NATIONAL PARK SERVICE PROJECTS OBLITERATION OF WEST'S SCENIC HERITAGE. ACID RAIN RESEARCHERS REPORT DAMAGE TO WESTERN HIGH COUNTRY. ACTION IS NEEDED TO PROTECT WEST.

STATEMENT BY
ENVIRONMENTAL DEFENSE FUND

Albuquerque, New Mexico
May 25, 1989

Presented by
Robert E. Yuhnke
Senior Attorney

The Western States Energy Board projects that electric power demand in the western states is growing at 2.1%/year, and will continue to grow at that rate for at least the next 10 years. 1/ EPA expects this increase in energy demand will continue until at least 2010 and be met by coal burning. If it is, EPA says that SO2 and NOx emissions from coal fired power plants in the 17 western states will approximately double between 1980 and 2010:

Million Tons/Year 2/

	1980	1990	2000	2010
SO2	1.2	1.5	2.2	2.7
NOx	1.5	1.8	2.1	2.9

Such large increases in the two pollutants that cause acid rain and degrade visibility present a severe threat to acid-vulnerable lakes and streams in the western high country, and will seriously degrade visibility in all the western states, including our spectacular national parks.

The National Park Service has analyzed the effect of the SO2 emission increases on visibility in parks throughout the West. Averaged across the region, the Park Service concludes that summertime haze will dramatically increase by 2010. The NPS analysis shows that bad pollution days, when visibility is severely impaired, will increase from an average of 9 days per summer to between 27 and 36 days per summer. 3/ This magnitude of visibility degradation is not acceptable to the millions of

Americans who visit our national parks each year, and will not be tolerable to those of us who live here.

Scientists researching the effects of acid deposition in the Rockies report acid pulse during the Spring snowmelt. At the longest running high altitude acid deposition research station in the West near Gothic, Colorado , Dr. John Harte of the University of California, Berkeley, reports the loss of 60% of the salamander population in watersheds above 10,000 feet. In testimony presented to the House Subcommittee on Health and Environment, Dr. Harte reports data showing the failure of salamander eggs to develop in the presence of acidified waters. 4/ In eastern lakes damaged by acid pollution, the salamander population was the first to be lost. Trout and other fish species followed later.

Dr. Harte's work is the only research in the western high country that has studied the effect of acid deposition on both lake chemistry and wild animals. The data base is unfortunately small, but it shows nature's early warning signals that acid pollution damage is beginning to occur at current levels of acid deposition. A doubling of acid deposition rates over the next 20 years could have disastrous impacts on the high country environment.

We need not sacrifice the spectacular scenic grandeur of the West as the price for growth, nor need we repeat the massive ecosystem destruction that has resulted from acid rain in the eastern US, Canada and northern Europe. Reasonable strategies are available to limit emission growth in the West while allowing increasing demand for electric power to be met.

In discussions with political leaders throughout the West, interest in addressing this problem has been coupled with concerns that any western SO2 and NOx emission control program meet the following criteria:

- it would impose no immediate control technology costs on utility sources
- specific control technology would not be mandated
- sources be allowed broad flexibility in finding the most efficient and least cost ways of limiting emission increases
- credit be given for investments in end-use efficiency that reduce demand for power and also reduce greenhouse gas (CO2) emissions
- allow co-firing with mixed fuels, such as increased use of natural gas as a low polluting supplement to current coal use
- emission trading be authorized within and between utilities and with other non-utility sources

EDF believes these criteria can be met by a program that would limit utility emissions in the West to 1985 emission levels, but allow broad-based discretion to the utilities to choose from among an unlimited array of options including load-shifting, co-firing with natural gas, energy efficiency programs that reduce demand and emission trading to obtain emission offsets if needed to accomodate increased power production or new construction.

Some have criticized such a program on the ground that it would limit development in the West. Such a result would not occur for many decades and then the program could be revisited by Congress. EDF has conducted an analysis of western emission data base developed by the western states under the auspices of WESTAR, the EPA sponsored western acid rain project. These data show that if the utilities employed none of the less expensive emission strategies available to them, such as co-firing with natural gas or energy efficiency programs, and chose to limit future emissions solely by installing emission controls on existing units to provide emission reductions as offsets against growth, then new power plants could be built to meet the expected increase in demand for power until at least 2040. This analysis assumes that all the emission reductions needed to offset growth would come from existing power plants, and that emission reductions from other SO2 and NOx sources are not used. If the utilities obtained offsets from refineries, pulp mills and natural gas sweetening plants in the region as well, then the period of unrestrained growth could continue even longer into the next century.

This analysis assumes that the best emission control technology currently in commercial use in the industry would be installed on new plants. This is the coal gasification technology installed by Southern California Edison at its Cool Water project in southern California. This 100 MW plant has operated for over four years and has demonstrated emission performance between nine and ten times better than the current federal new source performance standards for both SO2 and NOx from coal-fired power plants.5/ If more polluting technologies were used for new power plants, then the duration of the offset program would be shortened to some degree depending on the technology used.

EDF is currently preparing this analysis for public release and will make it available to the committee as soon as it is completed.

EDF asks the committee to give careful consideration to the need to limit emission trends in the West that threaten some of the most spectacular and precious resources we have: the almost limitless visibility that makes the American West unique on the planet and our pristine, but fragile, high country. The challenge for our generation is whether we can protect the beauty and splendor of our western land, while making room for and accomodating the needs of a growing urban population. We urge you not to shrink from the challenge. We need not sacrifice our common western heritage in the name of growth, but we do need to act now to adopt new policies aimed at protecting that heritage from otherwise inevitable degradation.

Respectfully submitted,

Robert E Yuhnke

Robert E. Yuhnke
Senior Attorney

TABLE I
UTILITY SO2 EMISSIONS (million tons/yr)
Prepared by ICF for U.S. EPA (1985) by controlled status of sources.

Year	1980	1985	1995	2000	2010
17 Western States					
SIP Sources	0.8	0.8	1.1	1.1	1.1
1971 NSPS (scrubbed)	0.2	0.3	0.5	0.5	0.5
NSPS (unscrubbed)	0.2	0.3	0.6	0.6	0.6
(Revised 1978) NSPS	0	0	0	0.1	0.5
Total	1.2	1.5	2.2	2.3	2.7
31 Eastern States					
SIP sources	15.6	13.3	15.1	15.8	16.3
1971 NSPS (scrubbed)	0.1	0.5	0.4	0.4	0.4
NSPS (unscrubbed)	0.5	0.9	1.0	1.0	1.1
(Revised 1978) NSPS	0	0	0.1	0.2	1.3
Total	16.2	14.8	16.4	17.4	19.0
Total USA	17.4	16.3	18.6	19.6	21.7
SIP Sources	16.5	14.1	16.2	16.9	17.4
1971 NSPS (scrubbed)	0.3	0.9	0.8	0.9	0.8
NSPS (unscrubbed)	0.7	1.2	1.5	1.6	1.7
Revised NSPS (1978)	---	0.1	0.1	0.3	1.8

FOOTNOTES

1/ Western Electricity Report, Committee on Regional Electric Power Cooperation, Western Interstate Energy Board (December 1988) [attached as EDF Appendix A].

2/ "Interim EPA Base Case Forecasts", Bruce Braine, ICF Inc. (Prepared for U.S. EPA, March 10, 1987), Tables A-9 and A-10 [attached as EDF Appendix B].

3/ "Impact of Projected SO2 Emission Increases On Visibility In Selected National Parks", National Park Service (Enclosure with letter from Christine Shaver, NPS Air Quality Division, to Robert Yuhnke, April 7, 1989) [attached as EDF Appendix C].

4/ Testimony Presented to the U.S. House of Representatives Subcommittee on Health and Environment, April 6, 1989, by Dr. John Harte [attached as EDF Appendix D].

5/ "Cool Water Environmental Performance Utilizing Four Coal Feedstocks," Rib, David M [attached as EDF Appendix E].

Senator BINGAMAN. Thank you very much.

Our final witness on this panel is Dr. John Bartlit, who is with New Mexico Citizens for Clean Air and Water in Los Alamos. John has been a leader on this issue in our state and throughout the country for a great many years; and we are very honored to have him here as a witness today.

STATEMENT OF DR. JOHN R. BARTLIT, NEW MEXICO CITIZENS FOR CLEAN AIR AND WATER

Dr. BARTLIT. Thank you, Senators.

I bring a message slightly different and broader than the notion of visibility is a "Western" issue or a national parks issue. Visibility is an everywhere and everyone issue. East or West, urban or rural, people do not want to live out their lives buried in smog.

As the Great Yellowstone forest fires wore on through the summer of 1988, the pall of smoke reached the once turquoise skies of New Mexico. The morning sun woke us to buried memories of visits to old steel towns like Birmingham and Gary. The evening sun floated like a pale tomato in cabbage soup. Newspapers and TV told the link between the distant fires and the depressing, dull days in New Mexico.

No person will say that the "Great Yellowstone fire" air quality was acceptable to him as a steady diet. Yet, according to all state and federal standards, that air quality is perfectly acceptable for every one.

The relationship between the concentration of particulate pollution in the atmosphere and visibility has been well known for more than 20 years. The Federal and State ambient air standards, the goals of our program, correspond to official range of about 12 miles. Even with the provision for the prevention of significant deterioration, visibility of 20 miles average will meet all legal requirements except in parts.

A visual range of 12 miles means that mountains more distant than 12 miles cannot be detected by eye. 12-mile visibility means the color and joy are lost for mountains much closer. During the dark days of the "Great Yellowstone Fire" New Mexico's visibility was never worst than about 25 miles, adequate to meet all state and federal standards.

Public opinion polls taken in Eastern industry towns in the 1960's included a 12-mile visibility which was perfectly acceptable to the public.

Increasingly thorough and sophisticated studies have been made in recent years to determine what value The Great American Public now places on visibility. These studies culminated last year in a publication by economists and scientists to try to determine the economic value of visibilty, which I have in my hand.

The 300-page book is meticulous in presenting the data that proves the public values visibility hugely. For example, visibility gains of three miles when the visibility is in the range of 9 to 14 miles were valued by Easterners at a total of $2 billion per year, as judged by their stated willingness to pay. Less you think that $2 billion per year to satisfy this is high, you will recall that soda pop is also worth billions per year simply because you and your neighbor are willing to buy a six-pack here and six-pack there as one of life's simple pleasures.

Industry labels visibility only aesthetic, but everyone wants some in their life. That is why the value of soda pop and visibility is gigantic.

What can be done to save the visibility that people value at millions per year? I urge the adoption of several Federal measures. They are:

(1) A regional cap (total limit) on emissions of SO_2 and NO_X;

(2) Tighten rules for automobiles; and

(3) Special consideration for "Integral Vistas."

As votes for the presidential nominees were cast at last summer's national convention in Atlanta, every state spent its moment on national prime time TV with a few words plugging the state's best attractions. The New Mexico words were: "Madam Secretary . . . New Mexico, the land of turquoise skies, is proud to cast . . ." Turquoise skies, a prime, unique, and advertised state and regional asset. Current state and federal clean air goals do not protect this asset.

I conclude with a four-point summary.

1. East and West visibility degradation is caused first by SO_2 emissions, and second by NO_X emissions. Organic carbons from fireplaces and autos is important to Western cities.

2. East and West the prime culprit is power plants. The solution is controlling the emissions. NO_X from autos also is important and needs attention.

3. The East and West visibility level is projected to worsen under current air rules. Emissions are projected to increase.

4. East and West people value visibility usually and want to protect it. Standards for visibility protection also provide better health and acid rain control as a matter of course.

Having said all this, my reason for being here today is that I love the turquoise skies of New Mexico. On returning from trips to the East, my heart leaps up. Some of you know the feeling. I wish it for all of you, regardless of your help.

Thank you, Senators, for listening and thank you for coming to New Mexico to hear our story.

[The prepared statement of Dr. Bartlit follows:]

New Mexico Citizens for Clean Air and Water

STATEMENT OF
DR. JOHN R. BARTLIT
STATE CHAIRMAN
NEW MEXICO CITIZENS FOR CLEAN AIR & WATER

BEFORE

THE U.S. SENATE SUBCOMMITTEE ON
MINERAL RESOURCES DEVELOPMENT AND PRODUCTION

ALBUQUERQUE, NEW MEXICO

MAY 25, 1989

PERSONAL BACKGROUND

My name is John Bartlit. I am the State Chairman of New Mexico Citizens for Clean Air & Water, a twenty-year-old statewide organization of citizens concerned about the environment. I have served as chairman and worked on environmental issues for nearly twenty years. My academic training is in chemical engineering, in which I hold a doctorate degree.

Those familiar with my views know them to be marked by a concern both for the environment and for the needs of industry. I firmly believe that mutually satisfactory solutions are available to be worked out among the various interests.

INTRODUCTION TO VISIBILITY

Visibility near the great parks of the West is priceless and at risk. But visibility is not a "Western" issue; nor a national parks issue. Visibility is an everywhere and everyone issue. East or West, urban or rural, people do not want to live out their lives buried in smog. This message and its proof is the subject of my testimony.

Regrettably, by nature most environmental standards must be set by dreary battles between high-powered experts, hired and volunteer, in obscure fields like marine biology, toxicology, and epidemiology. The public can but stand by, pick their favorite by the color of uniforms, and root loudly for their team.

Not so for visibility. Everyone is a qualified expert in saying what visibility is good and bad for him. This makes visibility one of the few technical and economic issues in which policy is properly based on public opinion.

As the Great Yellowstone Forest Fires wore on through the summer of 1988, the pall of smoke, half a continent wide, reached the once turquoise skies of New Mexico. The morning sun woke us to buried memories of visits to old steel towns like Birmingham and Gary. The evening sun floated like a pale tomato in cabbage soup. Newspapers and TV told the link between the distant fires and the depressing, dull days in New Mexico.

No person can be found to say that the "Great Yellowstone Fire" air quality was acceptable to him as a steady diet. Yet, according to all state and federal standards, that air quality is perfectly acceptable for everyone. How can this be? The history and meaning of today's rules strengthen my plea for better protection of visibility.

AIR STANDARDS AND VISIBILITY--MEANING OF THE STANDARDS

The federal secondary standard and the New Mexico ambient air quality standard for particulate matter is 60 micrograms per cubic meter, annual average. Standards set for fine particulate matter are equivalent to the 60 microgram standard for total suspended particulates. The Air Quality Criteria for Particulate Matter (Ref. 1) tells us that the visual range (visibility) corresponding to 60 micrograms per cubic meter is 6 to 20 miles. Twelve miles is the most expected value. These basic data are shown in the appendix to my testimony.

A visual range of 12 miles means that mountains more distant than 12 miles cannot be detected by eye. Twelve-mile visibility means the color and joy are lost from mountains much closer. During the dark days of the "Great Yellowstone Fire" visibility in New Mexico, visibilities were never worse than about 25 miles, much better than required by state and federal standards.

The relationship between particulate pollution and visibility has been well known to scientists for more than 20 years. After prolonged scrutiny, it remains one of the few environmental relationships that has never been in serious technical dispute. How then was so poor a standard selected in the first place?

HISTORY AND BASIS FOR CURRENT VISIBILITY (PARTICULATE) STANDARD

Today's standard was adopted in the early 1970's. No fundamental change in the numbers has occurred in the two decades since. The standards were chosen to meet people's stated desires on visibility, according to the public opinion polls back then. These data also came from the Air Quality Criteria for Particulate Matter (Ref. 2), and are also included in the appendix to my testimony.

The opinion polls were taken in St. Louis, Nashville, Birmingham, and Buffalo. The polls found, for example, that in St. Louis, only 30 per cent of the population thought there was any harm when the visibility was cut to 5 miles by particulate pollution. That was true in St. Louis in 1966. That is not true in St. Louis today. It was never true in the Southwest. Next I give the results from studies of current public opinion in the East. Similar, though less complete, studies have been done in the West.

CURRENT PUBLIC OPINION ON VISIBILITY--THE ECONOMIC VALUE OF VISIBILITY

Increasingly thorough and sophisticated studies have been made in recent years to determine what value The Great American Public places on visibility. These studies culminated last year in a publication by learned economists in collaboration with scientists from Argonne National Laboratory. The 300-page book is entitled The Economic Value of Visibility (Ref. 3).

The book is not an "environmental" book; it is a scholarly book. This is both its strength and its weakness. The book is meticulous in presenting the data that unquestionably prove the public values visibility hugely. For example, visibility gains of three miles when the visibility is in the range of 9-14 miles were valued by Easterners at a total of $2 billion per year, as judged by willingness to pay. Incidentally, the book attributes visibility loss to SO2 emissions, whereas I have talked in my testimony about particulates. The two are the same because SO2 turns into particulates reactions in the atmosphere. NOX acts similarly.

I have said the book's strength and its weakness is in being scholarly. The book demands diligence of the reader before releasing its nuggets of proof of the great economic value the public now places on decent visibility. The relevance to this hearing and unimpeachability of these facts demand that this committee and Congress, through their aides, make the effort to gather and digest the key findings of The Economic Value of Visibility.

A mini-digest of these findings is available in two columns I wrote for popular consumption in my local newspaper. The columns were only partly successful (the first one had a misleading headline, which prompted the second effort.) My two columns can be found in the appendix to my testimony to whet your interest, but again I urge study of the source book by policy makers. I have never said it before, but I feel the public is owed the effort on so important an issue as visibility protection.

People may have cared little for visibility in the East in 1966; today they clearly care much, in every part of the country.

CURRENT AIR RULES--DRAWBACKS AND PROPOSED REMEDIES

I have described the fatal flaw in today's ambient air standards as a protector of visibility.

In recognition of the need to do better, limited legislative steps were made in the name of visibility. I refer to measures for the "Prevention of Significant Deterioration" (PSD). Where it applies, PSD helps save visibility. One drawback of PSD is it applies only within large national parks and a few smaller ones. PSD leaves unprotected nearly all the area where nearly all the people spend nearly all their time. PSD does not help people who do not want to live out their lives buried in smog. It also does nothing to save scenic grandeur near parks. Other panelists will expand on this problem.

What can be done to save the visibility that people, East and West, value at billions of dollars per year? A solution that I do not advocate is a simple tightening of the ambient air standards. The appropriate standard would be too restrictive in many crowded areas. A tighter standard everywhere would limit options in plant siting.

Two better, and more flexible, proposals for protecting visibility have been made before. I urge the adoption of these measures. They are:

- (1) A regional cap (total limit) on emissions of SO2 and NOX; and
- (2) Special consideration for "integral vistas."

Integral vistas are especially valued views that are an integral part of the enjoyment of parks. Special consideration means giving special review to proposed large new pollution sources to determine whether really good pollution controls should be required on these large plants. "Really good" controls means controls that are really the best available. It is well known that the usual term "best available control technology" is a euphemism for "moderately good control technology." This must be true because there exists a higher category of more effective control technology known as the"lowest achievable emissions reduction"--LAER.

Urban visibility could best be protected by strengthening the NOX requirements for automobiles and the requirements for diesel emissions. More technical details on all of the above points are contained in the written testimony submitted to this committee by Dr. Michael Williams of our organization.

A FINAL WORD AND CONCLUSIONS

As votes for the presidential nominees were cast at last summer's national convention in Atlanta, every state spent its moment on national prime time TV with a few words plugging the state's best attractions. The New Mexico words were: "Madam Secretary...New Mexico, the land of turquoise skies, is proud to cast...." Turquoise skies--a prime, unique, and advertised state and regional asset. Current state and federal clean air goals (ambient standards) guarantee the eventual destruction of this asset.

It will happen slowly, as it did in the East where visibilities are now down to the low teens, but it will surely happen unless changes are made in rules. Easterners now say they are willing to pay $2 billion a year to recover just three miles of their lost visibility. A lot of visibility improvement can be bought with $2 billion a year invested in better pollution controls. When gains in visibility are bought, the same dollars also buy gains in less acid rain damage, better health, and less damage to plastics and metals we use daily. Acid rain and poor visibility are but two effects of the same cause--air emissions of SO2 and NOX.

I urge action by this committee to assure the effective protection of long-range visibility through amendments to the Clean Air Act. Protecting long-range visibility is a wise economic investment. Careful studies show it has the approval of a very broad cross-section of the American public.

Having said this, my reason for being here today is that I love the turquoise skies of New Mexico. On returning from trips to the East, my heart leaps up. Some of you know the feeling. Regardless of your help, I wish it for all of you.

Thank you for listening and thank you for coming to New Mexico.

John R. Bartlit, PhD
113 Monte Rey N.
Los Alamos, NM 87544
505-672-9792

REFERENCES

1. Air Quality Criteria for Particulate Matter, U.S. Department of Health, Education, and Welfare, National Air Pollution Control Administration, Washington, D.C., January 1969, pp. 3-18, 3-19 (Fig. 3-7).

2. Ibid., pp. 7-4 thru 7-8 (Fig. 7-1).

3. The Economic Value of Visibility, Blackstone Books, 1988.

APPENDIX

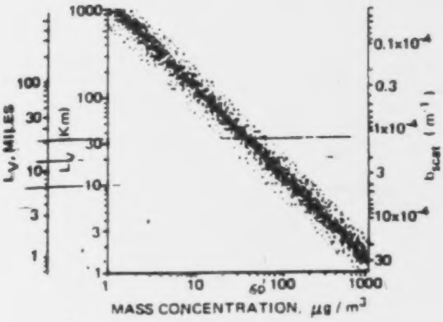


Figure 3-7. Relation Between Visual Range and Mass Concentration.

This figure shows the inverse proportionality between visual range and mass concentration described by equations 3-7 and 3-8.

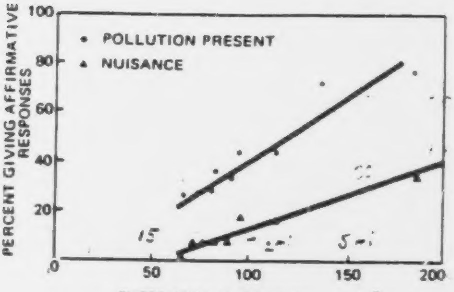


Figure 7-1. Proportion of Population in St. Louis Stating Air Pollution Present in Their Area of Residence, and Proportion of St. Louis Population Bothered.

This figure presents the results obtained from interviews.

JRB

Clean air rules and their costs

By JOHN BARTLIT
New Mexico Citizens for Clean Air and Water

In olden times, the joys of clean air were captured in words like these:

"Beautiful cloud! with folds so soft and fair,
Swimming in the pure quiet air!
Thy fleeces bathed in sunlight, while below
Thy shadow o'er the vale moves slow...."

In today's fight to save clean air, such testimony ain't worth two bangs on a washtub. You need facts. Facts come in units of dollars.

But hope glints on the horizon. Researchers are finding new ways to express human feelings — ways that one day may pack some punch in the regulatory arena. One of these ways looks like this:

[illegible]

These cold symbols represent the social benefits, in dollars, from improving visibility in the Eastern United States by a change in public policy, that is, a change in clean air rules. So say 12 learned economists, centered at the University of Chicago, in a new book titled "The Economic Value of Visibility" (Blackstone Books, 1988).

The book's analyses are based on surveys of how Jane and John Q. Public value visibility. Many of the studies done are "bidding games," designed to measure the public's willingness to pay to enjoy certain levels of visibility. The results are astounding.

A couple of cases give the flavor of the 300-page book. As determined by Argonne National Laboratory, the characteristic visibilities in 1980 are listed for the 26 Eastern states. The visibilities ranged from 8.7 miles in Ohio and Pennsylvania, to a high of 15.5 miles in Mississippi. Under current policy, those visibilities are expected to worsen by 1990 to where the best visibility is down to 14.3 miles, in Mississippi and Wisconsin. Studies in the book ascribe this damage primarily to SO2 emissions from industry and power plants.

The economists plugged in the numbers from economic surveys to find the value of achieving a 1-mile gain in the visibility expected in each state in 1990. The value, told in dollars, was $890 million annually.

New Mexico
Citizens for
Clean Air
& Water

Another case examined the benefits to be gained by cutting SO2 emissions to 50 percent below the requirements of current air rules. Again the numbers from the surveys were plugged in. The value of clamping down came to $2.06 billion annually. Yes, you read right — that is billion annually.

The $2 billion is just for visibility. It does not include dollars for any of the more conventional benefits of keeping the air clean — benefits like less damage from acid rain, less illness, higher yields of commercial crops, and less damage to metals and plastics we use daily.

The phrase — "more conventional" benefits — means more conventional to the nation. Los Alamosans know that visibility has been the No. 1 concern locally since the first day of the fight for clean air in New Mexico. Time may be proving Los Alamosans are more typical of human beings than industrial polluters may have thought.

A quirk of physics makes visibility pivotal in the fight for clean air. By chance, the amounts of sulfur and smoke that barely harm health severely hurt visibility. Industry has long conceded the importance of health, but has passed off visibility as a bauble for the few.

Studies now value the "bauble" at $2 billion a year. Why so much? Pollution-related illness hits the weak, the vulnerable, the old and the very young. Although at times a matter of life and death to these, it affects most people unnoticeably. Visibility earns a big price tag from Easterners because its loss impacts everyone, all the time, and in obvious ways...going back to sunlit vistas, and shadows on vales.

One hopes "The Economic Value of Visibility" marks the dawn when the economists see what poets have been fumbling with, lo, these long years. The next difficult step is to make it understood by legislators and regulators.

• John Bartlit is the state chairman of New Mexico Citizens for Clean Air & Water.

Visibility gains worth $2 billion

2-8-89

Editor's note: The Monitor headline on Mr. Bartlit's column on Jan. 29 missed the point. The writer realized that if the newspaper could miss a point, most readers would miss it too. Because the subject is critical to the success of clean air in New Mexico, Mr. Bartlit asked for a chance to rewrite the column. Here is the result.

By JOHN BARTLIT
New Mexico Citizens
for Clean Air & Water

If money bought happiness, how much would you be willing to pay for your view of the Sangres? How much would everyone be willing to pay for every vista in America?

A new book titled "The Economic Value of Visibility" gives some huge answers. Many Easterners were asked what they would pay to gain 1 mile of visibility in their land, where visibilities are 12 to 14 miles. Their answers totaled $890 million a year. This was the conclusion of 12 university economists who collaborated with Argonne National Laboratory on the book.

Easterners were further asked what they would be willing to pay to gain three miles of visibility, and let a little more scenery show through. Their answers were whopping $2 billion a year.

How did the economists arrive at the number $2 billion? The same way you would. They asked the man on the street. Using photos of scummy days and better days, they asked people what they would pay to see more of the happy days. They asked folks from all walks of life — all ages, education levels, incomes, occupations, recreation interests, family sizes, town sizes and places. Some worked in smokestack jobs. Some were jobless. They even asked those whose bag is big-screen ballgames at bars.

New Mexico Citizens for Clean Air and Water

Mr. and Ms. Average J. Doe and friend said, for their household, they would be willing to pay $10 to $60 a year for better visibility. Pennsylvanians and New Yorkers were willing to pay more. Alabamans and Illinoisans thought not so much. In the 26 Eastern states, $10 to $60 a household totals $2 billion a year. It is the same way soda pop is worth billions a year because you and your neighbor are willing to spring for a 6-pack here and a 6-pack there to enjoy life.

Why are these big numbers important to Los Alamos? From the first, visibility has been the No. 1 pollution concern here. Our vistas are wide and (usually) clear. We love our Southwestern vistas.

Argonne Laboratory found the chief villain in ruining Eastern visibility is SO2 from industry and power plants. Unfortunately, the amounts of sulfur and smoke that barely harm health severely hurt visibility. Industry has long conceded the importance of health, but has passed off visibility as a mere bauble for the few.

"The Economic Value of Visibility" seriously appraises this "trinket" for the first time. We find out the "trinket" is worth $2 billion a year, many times over. At last we have the economic facts to destroy industry's scrappy defense of foul air.

It's about time.

• John Bartlit is the state chairman of New Mexico Citizens for Clean Air & Water.

Senator **Bingaman**. Thank you very much.

Let me ask a couple of questions, then I will defer to Pete to ask any questions he has.

I guess my first question would be to Bob Yuhnke and John Bartlit. I gather there may be a difference of opinion between the two of you as to what the reauthorized Clean Air Act ought to provide. If that is not the case, maybe you can clear that up.

Bob, I understood you to say that we should hold the line. We should not cut emissions, but we should hold the line where they are.

And, John, your comment was that the standards need to be improved. Perhaps we can hold the line on emissions while still improving standards very substantially to bring the standards into line with the emissions.

If you folks can clear that up, I would appreciate it.

Mr. **Yuhnke**. I think it is easy to clear that up, Senator. We would love to see the condition that I have demonstrated here with these Grand Canyon slides improved. We have certainly raised that objective with a number of members of Congress. But in talking to various political leaders around the West, the message that we have gotten loud and clear is that even those who are sympathetic to addressing this need, they do not feel there is a political base today for imposing immediate costs on the utility industry in the West.

So our response to that has been to try to work with members who have expressed an interest in developing a program that does not impose immediate costs on the utility industry in the West. But instead is based upon the idea that industry should plan for growth, plan to meet electric power needs, but to do so in a context where emissions are not increased. And it is largely a political judgment that drives me to ask you to support a program of that kind rather than my heart, because my heart says we can do better.

Senator **Bingaman**. John, did you have a comment on that?

Dr. **Bartlit**. Yes, our positions are certainly very compatible with each other and are consistent. I support—and really it is really from the same place. Lowering the standards, setting the standards where they need to be set to protect the kind of visibility that people really love and really want nationwide is a political and impracticality and probably a technical impracticality also. I do not think it can be done or should be done.

A notion of controlling emissions overall by another mechanism, keeping a cap where the emissions are in the West, and lowering those total emissions of sulfur in the East, which is what the acid rain legislation before Congress does propose for the East, and keeping a cap where it is in the West, I support wholeheartedly; and I think it is a reasonable, practical approach to doing what can be done at this time for the problems we are concerned about.

Senator **Bingaman**. Let's discuss the idea of a regional cap. Several years ago, I can recall substantial publicity about the coming on of new smelters in northern Mexico, and the impact that was going to have on our state and on the Southwest in general in this region as far as the quality of our air.

Is that still an issue? If so, what do we need to be doing about it? Is there anything that the Congress needs to consider with regard to that in setting regional caps?

Mr. YUHNKE. Senator, the admiministration was very responsive to the concerns expressed by yourself and Senator Domenici about that Nacozari smelter. As a result of that there was an agreement signed with Mexico which provided for the installation of control technology on that smelter. Those controls became operational at the end of July last summer. Since then people who live down in southern Arizona that can see that stack say that the performance of those controls have been sporadic, because some days they see no plume at all. Other days they have seen a pretty strong plume.

Under that agreement Mexico was supposed to have installed emission monitoring devices, such as we require on sources in this country, and to have reported those emissions on a quarterly basis; the first report due in November of 1988 to the United States Government. That report has not been filed to date, and we do not have that information. It would be very helpful, very helpful, if you would raise your concern with the Environmental Protection Agency, asking the EPA to insist upon the filing of those reports by Mexico.

Senator BINGAMAN. I will be glad to do that.

Let me ask Bob Luna one other question, and then defer to Pete for any questions he has.

You have described one of the suggestions that your group, Technical Advisory Group, came up with, a year-round oxygenated fuels generation test. Is that the right title?

Dr. LUNA. Yes, sir. The concept is to require use of oxy fuels on a year-round basis for one or two or perhaps a slightly longer time in order to test the theories that currently exist with regard to the benefit of oxygenated fuels on overall emissions from motor vehicles and the postulated resultant decrease in ambient concentrations of CO and hydrocarbons.

Senator BINGAMAN. How extensive of an effort is this? How expensive? What is needed in order for us to go ahead and do this test?

Dr. LUNA. I think there are certain legal and regulatory requirements that need to be put into place in order to authorize this, so it will have the cooperation and consensus developed both at Federal, State and local levels. The technical aspects of the problem, we are talking about a science and technology program that might amount to $8 to $10 million over a 2- or 3-year period in order to fully characterize the sources and the response of the fleet to the oxygenated fuels.

As I indicated, this is a very extensive project, and there would have to be a very significant amount of cooperation between the oil companies, the regulators, the lawmakers, et cetera, in order to make it pay off insofar as demonstrating the expected efficacy of oxygenated fuels.

Senator BINGAMAN. Without something like this being done, we really do not have good data with which to measure the value of oxygenated fuels? That is what I am understanding from what you said.

Dr. LUNA. All of the documents that we have seen with regard to the benefits of oxygenated fuels are based on limited samples of vehicles, or are based on EPA models of what emissions are supposed to be. Even, for instance, the Denver numbers from the Denver 1-year wintertime experiment, which projected I think it was a 9-percent decrease in CO emissions, CO concentrations, were all largely based upon projections by computers. Not really measured and verified in the way that makes people involved in science and technology feel very comfortable in saying, yes, this is a very viable and demonstrably productive way of proceeding to reduce pollution.

Senator BINGAMAN. Thank you very much.

Pete.

Senator DOMENICI. Thank you, Jeff.

Let me stay with you for just a minute, Bob. On that issue of a year-round oxygenation test, if one was to ask that a detailed program for that be written up, and if you had to start with the premise of saying, if our suspicion is right, it could have a very big impact on clean air and attainment, how would you describe that possibility? This is a significant part of our overall strategy.

Dr. LUNA. The papers that I have seen with regard to wintertime and summertime impacts suggest that the oxy fuels program may be as much as a 10- or 12-percent decrease in CO emissions in the wintertime. And that is very dependent, I think, upon the age of the fleet and the makeup of the fleet. And in the summertime I think the paper I have seen by some folks done on the West Coast, based on modeling, suggest that it might be a 20-percent or so effect on hydrocarbons and hence on oxygenates.

So the impact is one which is probably as important as the inspection and maintenance program. Probably less important than some other things that you might do on a local area of signal synchronization and things like that. If the projections are correct, it is potentially a useful reduction in emissions.

What concerns the Technical Assistance Committee is some of the other work that we have seen generated by Professor Stedman, among others, with his machine that suggests that some of the EPA models are not all that correct. And some information that suggestions that this theory about the efficacy of oxygenated fuels needs to have greater substantiation in a large scale test where people and large fleets are involved. That is really where this is going.

Senator DOMENICI. I personally believe that somebody ought to describe for us the essence of this problem, and the confines and input that would have to take place in such a test. I think that would generate some interest if something like that was done. I am not suggesting, Bob, that you should; but if you have the wherewithal, I think a description of what we have to do and why, and its estimated cost, and how to do it should be available someplace for us to do this; at least to take a look. I am not suggesting the committee take a look.

Can you tell me whether that could be done by your group, or should we look for somebody else?

Dr. LUNA. Senator, I believe that ours is a volunteer group and is probably not the place to do this. One of the things that I think is a part of the proposal that we put forward, and I might add this proposal is very, very loose at this time, and points to a problem and need for verification, rather than a detailed technical plan.

But the first part of any technical proposal and the first part of any research activity has to be an evaluation of the literature and evaluation of what it is you are trying to achieve and address in evaluating previous literature and previous understanding in a way that develops the rationale for the remainder of the study. That, in fact, would certainly go forward before any of the big bucks kind of activities that are involved with actual fuel switching and instrumentation should or ought to go forward.

Senator DOMENICI. I will try to go quickly, Senator.

Let me just say with reference to the visibility issue, I personally am genuinely interested in what you presented, Bob. I saw this yesterday when you visited me. I think Albuquerque is a living example of the fact that people are very concerned about this visibility. As a matter of fact, when we asked Sandia years ago to look at the green cloud, it turned out their report was rather shocking because of what we are seeing has nothing to do with the health standards and attainment of health standards, but rather an obnoxious condition that exists that people do not like and they should not.

I will tell you one of the thrills, speaking of the beauty of this clean air, is to fly in at night and see the absolute beauty of the lights when it is pristine clear, and then see the lights of Albuquerque as you fly in when it is the opposite. You can see it dramatically as you come in and come home and land.

But let me ask with reference to the Southwest, Grand Canyon and the other and the cap concept; how certain can we be if we move in this direction that we understand that the cap will work? I mean obviously the first question that will be asked is: Do not air currents move? We find air from here all the way up to Canada. If we cap here within a region, how certain are we that the conclusion will be the reduction of the expected bad effects? Have we done that in some scientific way?

Mr. YUHNKE. I think there are a couple of questions inherent in your question. One is how well do we know what pollutants are responsible? So if we cap these pollutants, are we going to get a benefit?

I think on that score the work that the Park Service has done over the last eight or nine years to characterize the cause of visibility impairment in the national parks has been very good. It has been published, peer reviewed. I do not think there is much disagreement in the scientific community about the causes of visibility and impairment that is being measured in the national parks.

So that if we cap these two pollutants—one pollutant that we will be leaving out, which is significant today, is the organic carbon compounds, which are primarily related to tailpipe and diesel emissions. If we address those in the urban environment, which is primarily where they come from, then we will be addressing those also, but not within the context of regulating utilities.

I would say there are three questions here. Another question is, if we are willing to put a cap on utility emissions, will we know that we are going to solve this problem? That involves some questions of judgment about where growth is going to occur with regard to polluting sources.

When we looked at that issue for the West, it looked to us like the other major sources of these pollutants and in the context of nitrogen oxides, utilities account for 75 percent of the emissions, and in the context of sulfur dioxides the utilities account for 50 percent of the emissions.

It did not look like the other industrial sources were going to grow substantially. No one is planning to build a new smelter that we know of. No one is planning substantial expansion of a refinery that we know of. No one is planning substantial expansion of the pulp or paper industry. There may be some increase in industrial boilers, but that we think is pretty small piece of the total. On that score we think that regulating the utilities will get probably 90 percent of emission growth; not all but enough.

The third issue is whether or not this program will work administratively. Can we build a scheme that will work across state lines? I think that is the issue that we grappled with the most. It is the one where we have been most engaged in discussions with members of Congress of how to piece this thing together.

I think that is a question of how we build the program. We do not have experience with this kind of multistate regulatory program for the states to cooperate, and we have to be careful about how we put that together. But I think that is where the creativity of folks like yourselves will come into play, and drawing upon your political judgment to make sure that we put in place the pieces that will make sure that it works.

Senator DOMENICI. My last question. John, with reference to New Mexico powerplants, how do you envision this kind of cap affecting visibility?

Dr. BARTLIT. If it were to apply here as everywhere else, the sulfur controls on New Mexico powerplants now are quite good compared to most plants in the West, which means that they would have less ability to reduce emissions. The places you can reduce emissions most from are places that are poorly controlled. Another thing you could do, and this could be beneficial to New Mexico and its utilities, is that there would be some utilities in general that would look at an alternative to shift load to plants that are well controlled instead of building new controls on poorly controlled plants. That could increase the capacity factor of the plants we have in our state, which is a goal desired by industry and economic interests and environmentists alike, assuming you can keep those emissions controlled.

Senator DOMENICI. My last question: Bob, Sandia Laboratories has been involved for some years in the various aspects of this, and now as a specific way that you have described today. Could I just ask a general observation, no long dissertation, because I do not want to use time. But do you feel that the laboratories have a role that Jeff and I could talk about that is national as in clean air evaluation and considerations that is beyond just the scope of the local involvement?

Dr. LUNA. Well, Senator, I think the laboratory has had a program in the atmospheric sciences for some time, and I expect it will have one in the future, which is, in fact, nationally recognized.

The program is very limited in scope and is always looking for good research problems that offer a technical challenge as is always the case with the laboratory. These local programs, in fact, do have a national component and national application that I think is important; and that you could, in fact, inspire and encourage.

Senator DOMENICI. I do thank you, Mr. Chairman.

Senator BINGAMAN. I have one other question to ask Bob. Your working group, this Technical Advisory Group, primarily has focused so far on Albuquerque and the situation right here. Is your group willing to try to do the same kinds of review of the situation in other parts of the state, in Las Cruces or other areas? Are you able to follow up with some of the recommendations that we hear today to give us your assessment of those?

Dr. LUNA. Yes, sir, we are certainly willing to continue to exist to help you in these problems. We are certainly willing to act to assist other municipalities within the state in understanding their projects, and, in fact, we are certainly open to including people from technological organizations in the local areas to make sure that the local experience is included in every case.

We had envisioned to be a relatively limited time activity, but I think it is clear that the problems will persist and the need for some technological evaluation will also continue to exist. And the laboratory has always been very supportive in supplying the manpower to do that, and I am sure the city and other organizations currently involved in the TAG would certainly do the same.

Senator BINGAMAN. Thank you very much. We appreciate all the good testimony from this panel.

We will go ahead with the second panel at this point. I think the second panel consists of four individuals, Dr. James Fouts, Dr. John Spengler, Dr. Robert Bethel and James S. Cannon. Let me thank this group for coming. This panel is going to focus on health effects of pollution.

We will go in the order that I indicated before. Our first witness will be Dr. James Fouts, who is senior scientific advisor to the Director of the National Institute of Environmental Health Sciences at the Research Triangle Park, North Carolina.

Dr. Fouts, thank you for coming to Albuquerque, and we look forward to hearing from you.

STATEMENT OF DR. JAMES R. FOUTS, SENIOR SCIENTIFIC ADVISOR TO THE DIRECTOR, NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

Dr. FOUTS. It is one of my favorite cities. My father lived here many years ago.

I have been asked to summarize the NIEHS supported research in the human health effects that are——

Senator BINGAMAN. Could you pull that microphone up just a little bit so everybody can hear?

Dr. FOUTS. First, a little history: From its very beginning the NIEHS has had a program in health effects of air pollution, and some of our earliest research efforts are described in the material I submitted, copies of which are outside.

I wish to point out here that our in-house inhalation toxicology facility, which was built in 1970 in Research Triangle Park, was part of my grant when I first came here; was the best in the Federal Government at that time for such studies. It was here that the first studies on health effects of sulfuric acid mists were done. Sulfuric acid is a major component of urban pollution.

NIEHS long-term support of basic health research, toxicology of air pollution and lead has served agencies like the Environmental Protection Agency in setting its criteria for air pollution; for controlling the pollutants that might injure human health. It is the NIEHS' support of research centers at universities like Cincinnati, New York University, Rochester, University of California at Berkeley, MIT and Mount Sinai that have been crucial in their results and tests they have done in most of these standards that we now have, and others that will be coming along.

You will hear more about one of these when Dr. Spengler, who is at our university-based center at Harvard. They have done a very crucial first 6-city and not 24-city studies that are serving very well in that respect.

Presently all of our additions at NIEHS, both extramurally and intramurally, support research on human health effects of air pollution. It is from these studies that we have identified some key questions and some approaches and practical suggestions that can be made. Several of those specific findings are mentioned in the report, as I say, that I presented to the committee for the record.

Just a few examples right here about acid aerosols and rain, which you have already heard. There are both direct and indirect, the human health effects. The direct effects are on the lung. The indirect effects are via the effects of acids in solubilizing particular metals from the soils and polluting water and food. The direct health effects on the lung are summarized well in a conference proceeding. The conference was held at NIEHS about a year ago. The proceedings of that conference have just been recently published in our journal Environmental Health Perspectives. A summary of that is included again in the material I submitted for the record.

Major unresolved issues that came out of that conference concerned interactions of key air pollutants. You have heard about specific single pollutants, but interactions of these seem to be able to produce synergism or damage to the lung particularly in susceptible people. I am speaking here of acids, plus ozone, plus particles, which seems to be a very particular potent combination.

Key markers to serious pollutant damage to the lung are now being made available through the most recent research efforts, particularly biomarkers. We have not until this time been able to have extremely sensitive and very specific markers of pollutant damage and have had to worry about the contributions of other things like viral infections or allergies to the problem. These probes will help us to be more specific and much more definitive in what we are really seeing as the human health interacts with specific air pollutants.

Indirect health effects, as I said, are due to solubilizing metals, particularly from soil, acids in acid rain and in aerosols. The metals of concern here are lead, arsenic, mercury, cadmium, aluminum. NIEHS has been a major supporter of human health effects research in all metals, but particularly these of the indirect acid rain effects.

Our recent conferences on lead and the upcoming conference in three weeks on mercury will define the best research that is now available and the actions that can be taken based on that.

Our national toxicology programs on risk assessment gives us new tests in the evaluations of key pollutants. They will give us the indications which are more most dangerous and how we can follow the particularly exposed populations at risk.

New ways of doing those tests will come from things like biomarkers and immunotoxicology and reprotoxicology tests that are now in the process. We will be doing specific chemical studies in the NTP on things like methylene dichloride, formaldehyde, which will cover oxygenated fuels and things that are particularly important to mixtures and interactions.

So NIEHS supported conferences give us the cutting edge of the human health effects research that is going on. Our NIEHS supported university-based research centers represent an international, not just national, resource for addressing the major still unresolved issues and what are the best approaches that we now have for those things.

[The prepared statement of Dr. Fouts follows; the additional material has been retained in subcommittee files:]

DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

National Institutes of Health
National Institute of
Environmental Health Sciences
P.O. Box 12233
Research Triangle Park, N.C. 27709

Testimony of Dr. James R. Fouts, Senior Scientific Advisor to the Director, National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health, to the Subcommittee on Mineral Resources Development and Production of the Senate Energy and Natural Resources Committee Meeting in Albuquerque, New Mexico, on May 25, 1989.

I was asked to describe the NIEHS-supported program in research on the human health effects of air pollution. I will do this in two parts—an historical perspective (where we have been) and the present programs.

1. History

NIEHS has had a program in health effects of air pollution from the earliest times up to the present.

a. Early inhalation toxicology research at NIEHS

Inhalation toxicology was one of the strongest of the early programs of NIEHS here in North Carolina. NIEHS built a state-of-the-art inhalation toxicology research facility in early 1970 and recruited its leader from one of the strongest University-based Environmental Health Sciences Centers. Dr. Robert Drew (from New York University) ran the NIEHS in-house facility from 1970 to 1978. One of the purposes of this new facility was to prepare and study in animals the health effects of complex/unusual aerosols or mixtures. One of the mixtures studied by Dr. Drew in this facility was sulfuric acid and ozone, a major constituent of present day city air.

b. Intramural pulmonary/lung research progams

Some of the earliest NIEHS intramural (in-house) research programs dealt with pulmonary damage by air pollution chemicals. The Pharmacology/Toxicology Branch (PTB) was the center for at least ten years of most of this in-house work. Later the Branch spawned several other "pulmonary" programs which became independent Laboratories/Branches (Laboratory of Organ Function and Toxicology; Laboratory of Pulmonary Pathophysiology). Some of the earliest PTB work was with isolated perfused lungs and isolated lung cells. These lungs/cells were used in studies of lung secretions/surfactant synthesis, as well as in studies of the metabolism of air pollution chemicals and the relationship of this metabolism to lung damage by these chemicals. Among the air pollutants studied in early PTB work were things like benzo(a)pyrene, benzene, xylene, styrene, and dichloromethane—these are among the most common constituents of air pollution today.

c. Early University-based Environmental Health Sciences Centers (EHS) and other programs in air pollutant effects

In the earliest years of NIEHS a number of grants and contracts to study the health effects of air pollution were operating in addition to the in-house studies just mentioned. For example:

(1). "Smoking" dogs and miners studies: These were contracts concerned with the health effects of diesel smoke (as measured in dogs), and the health effects of combinations of cigarette smoke and uranium mining gases (radon, etc.) in humans. These studies began before 1970 and were some of our first human studies. This was one of the first NIEHS-supported studies on synergism between cigarettes and other air pollutants.

(2). New York University—(one of our earliest EHS Centers): This Center has had one of best inhalation/pulmonary toxicology facilities/programs for years—studying a variety of pollutants and mixtures. Here were the earliest studies on synergism between common air pollutants (e.g., SO_2 and benzo(a)pyrene [BP]—gave more cancer than either alone in animals). This research was done by Drs. Drew, Kuschner, Laskin et al. It has cooperated extensively with other researchers in studies of health effects of air pollutants in humans and animals. Some of the best work on mechanisms of lung damage by pollutants was/is done at this Center (e.g., by Drs. Lippmann and Schlesinger). Some of the most useful studies on the health effects of acid rain/aerosols comes from here.

(3). Massachusetts Institute of Technology (MIT): MIT had one of the earliest groups studying health effects of pollutants emitted from incinerators. Also, they did early research on mechanisms of lung damage by a variety of air pollutants—especially SO_2 and ozone (e.g., Dr. Amdur's early studies on SO_2 effects on airway resistance). This research led to better markers and tests for such lung damage in animals and people (e.g., markers studies by Dr. Thilly).

(4). University of California (Davis): Since 1972 Dr. Dungworth has studied air pollution effects in animals particularly effects of ozone, constituents of SMOG, etc. This is one of longest running of our air pollution grants.

(5). Harvard University: Major research has beenn conducted here to understand the effects of ambient air pollution on lung functions in persons living in cities of differing air pollution types. This is the long-running (more than ten years now) "6 Cities Study" which is just ending but is the basis of the criteria set by the Environmental Protection Agency (EPA) for several of the "criteria air pollutants". This Center is a world leader in such epidemiological studies and has devised new ways/methods to study both the pollutant compositions and their effects in humans--and especially children. Additionally, both indoor and outdoor air pollution effects are studied.

(6). Mt. Sinai University: For twenty years the most famous EHS/air pollution efforts have been at Mt. Sinai on lung damage from asbestos. Here too, is/was the study directed at describing the ill health effects of the combination of smoking and particles/asbestos.

(7). Lead--one of the criteria pollutants: NIEHS has been a leader in supporting this health effects research for our entire history. Several EHS Centers are involved. Cincinnati is one of the major ones. This is the long-range research (greater than 20 years) which has culminated in the present realization that current health standards for lead are inadequate, especially to protect the health of the fetus/young children. There were also NIEHS-supported studies in humans on things like lead poisoning by fumes from cutting torches (from lead paint on bridges/girders etc.), or at police firing ranges (from lead jackets on bullets). The EHS Centers in New York City were very active here.

d. Other activities

Conferences

NIEHS has sponsored many conferences on the health effects of various aspects of air pollution. Many of these conference proceedings were published as monographs in the NIEHS journal: Environmental Health Perspectives. Some early air pollution conferences were:

(1). Vol. 7: Low Level Lead Toxicity

(2). Vol. 9: Asbestos

(3). Vol 10: Mobile Air Emission

(4). Vol. 16: Target Organ Toxicity: Lung

(5). Vol. 22: Air pollution and Human Health

2. Present activity

NIEHS has a wide variety of research on health effects of air pollution. We support such research intramurally, as well as extramurally (in Centers and by individual grants) and on contracts. A complete description of all this work would take too much space/time here. Some of the attachments describe selected parts of this relatively large program but are not exhaustive. I have selected some aspects of the overall program for description here:

a. Intramurally

(1). Inhalation toxicology

NIEHS still supports much research here—largely by the National Toxicology Programn (NTP)/contracts. Some of the recent in-house evaluations include chemicals found in many city airs; e.g., dichloromethane or various forms of asbestos and other insulating fibers. NIEHS studied the health effects of methyl isocyanate (MIC) right after the Bhopal Disaster. A new study on the health effects of ozone has just started and is described in one of the attachments.

(2). Basic research

NIEHS supports much work on mechanisms of lung cancer from specific chemical entities like dichloromethane (Dr. Anderson/Division of Biological Risk Assessment [DBRA]) or asbestos/fibers (Drs. Barrett and Brody), or BP/polycyclic aromatic hydrocarbons (PAHs) (Dr. Nettesheim). This research aids in designing new tests for exposure/effects; e.g., the possible use of oncogenes/adducts as markers of lung exposure (Drs. Anderson; Devereux/Reynolds—DBRA). Drs. Deveruex/Reynolds (DBRA) continue their studies on isolated lung cells/formation of adducts by cigarette smoke constituents as markers for damage and exposure/predictors of lung toxicity. Dr. Hook continues his studies on lung cell secretions (type II cells and surfactant synthesis and secretion) and the effects of pollutants on these cells and their secretions. DBRA/epidemiology is doing a study about the human health effects of radon in smokers vs. non-smokers and has just recently completed a study in humans on passive smoking effects/indoor air pollution. Dr. Philpot (Intramural/DIR) continues his long-term studies on lung metabolism of chemicals and relations of this metabolism to lung damage by these chemicals. Dr. Luster (NTP/DTRT) is studying the effects of air pollutants on immune systems and the possible use of immune markers as exposure indices.

b. Contracts

Most of these deal with specific pollutants and studies of their effects on whole animals or marker systems. Some examples here:

(1). Relatively routine inhalation/toxicology studies of solvents/common chemicals found in air pollution (e.g., butadiene, isoprene, dichloromethane, tetrachloroethylene, acetonitrile, nitromethane.

(2). Development/validation of better methods for detecting health effects (e.g., immunotoxicity studies by Dr. Luster; reprotoxicology studies by Dr. Schwetz).

c. Extramurally

(1). Centers

(a). Harvard

The "6 and 24 Cities Studies" of health effects of several "criteria" air pollutants—especially SO_x, NO_x, Ozone, particles (several sizes)—with emphasis on children/asthmatics as particularly susceptible populations. The Cities (6 and 24) are chosen to reflect different kinds/levels of ambient pollution and to allow distinguishing effects of high vs. low SO_x, NO_x, and ozone. These studies also monitor indoor air pollution and cigarette smoke concentrations and correlate all these (indoor and outdoor air measurements) with health effects. The 24 Cities are in both the U.S. and Canada. This is the Center/grants that devised the new better ways of identifying and measuring the key contributors to lung damage—e.g., acid (not SO_2); fine particles (not just all particles; dry vs. wet aerosols.

(b). New York University

There is a wide variety of current projects here—dealing with criteria pollutant effects in animals and humans. This is a major resource/leader group for designing better markers of dose/effects and studying lung functions most sensitive to damage. Dr. Amdur is here now and will be starting up new studies of effects of particle/pollution mixes. A chief mover here is Dr. Lippmann with his studies on pulmonary functions/deposition of particles, etc. Also here is Dr. Schlesinger with his studies of key air pollutant effects (e.g., NO_x, ozone, sulfuric acid) on lung defenses and his defining of active ingredients of mixtures; e.g., acid not SO_2.

(c). Cincinnati

Together with NIEHS-supported grants in Boston, these are the major epidemiology studies of the health effects of lead—particularly in young children. These grants devised better tests for the subtle neurological/behavioral effects of lead. Here too are studies and evaluations of how to clean up environmental (e.g., housing) lead contamination to protect the susceptibles.

(d). Massachusetts Institute of Technology

Study of better markers of pollutant exposures and serious effects (e.g., by using oncogenes and adducts). Study of methods of incineration of wastes and how to effect such degradation with less impact on ecology and human health. Some parts of this research (especially the ecology and engineering studies) are supported by an NIEHS Superfund grant.

(e). University of California - Berkeley

An NIEHS Superfund grant is used to devise better methods to analyze mixtures and define exposures (adducts and oncogenes)—working also with the Univ. Washington (Seattle) to study populations of workers exposed to styrene, or benzene—common air pollutants.

(f). University of California

Davis Looking at incinerators and methods of defining better methods/detecting pollutant exposures. Studies of acid rain/air pollutant interactions.

(2.) Other grants

(a). NIEHS initiated three new grants investigating the toxicology of aluminum—a metal mobilized from soil (into water) by acid rain.

(b). R. Frank at Johns Hopkins—research on pulmonary effects of acid aerosols—animals and humans.

(c). Hackney at Downey, CA—also studying acid aerosol health effects in humans.

(d). Lovelace in New Mexico has historically had several NIEHS-supported activities in air pollution effects—recently Dr. Henderson with studies of markers of exposure to pollutant gases.

(e). University of Washington, Seattle—in addition to the Superfund Center grant (see above collaboration with University of California, Berkeley). There are epidemiology studies about air pollutant effects in susceptible populations; e.g., asthmatics (Dr. Koenig).

(f). University of Rochester has several grants too; e.g., Oberdoester's study of chronic injury by inhaled pollutants (particles); Utell's studies of oxidants and particles combinations effects on lung functions.

A fairly complete listing of NIEHS-supported grants dealing with the health effects of air pollution is given in the handouts. I have tried to select and describe a few of these.

d. Other Activities

Conferences

NIEHS has continued to hold conferences at regular intervals on various aspects of the health effects of air pollution. These conference papers are usually published in the NIEHS Journal, EHP. NIEHS attempts to update particularly active/important areas; e.g., NIEHS has had two major and one small conference on the health effects of acid rain/acid aerosols in the last four years. Some other recent conferences on air pollution and their references in EHP are:

(1). Vol. 47: Mutagenicity and Carcinogenicity of Air Pollutants

(2). Vol. 52: Air Quality Control

(3). Vol. 53: Asbestos

(4). Vol. 55: Pulmonary Toxicology

(5). Vol. 56: Methods in Pulmonary Toxicology

(6). Vol. 58: Formaldehyde

(7). Vol. 63: Health Effects of Acid Precipitation

(8). Vol. 70: Airborne Pollutants and Respiratory Cancer

(9). Vol. 73: Nitrogen Oxides

(10). Vol. 78: Lead/Blood Pressure Relationships

(11). Vol. 79: Health Effects of Acid Aerosols

Note that these conferences include a wide spectrum of activity thought to be needed to evaluate the human health effects of air pollution; e.g., attention to specific components and problems, development of new methods, epidemiology of effects, and basic research on mechanisms of pollutant effects. Both basic and applied research are covered in almost all of these conferences/reports.

Summaries of three recent NIEHS conferences on air pollution problems are in the handouts:

(1). Dr. Lippmann's summary of the "Health Effects of Acid Aerosols" Conference held at NIEHS in September 1987.

(2&3). Dr. Kathryn Mahaffey's summaries of two conferences on the health effects of lead:

(a). The newest findings about human health effects of very low level lead exposures.

(b). The newest methodology for measuring body lead stores by two different kinds of X-ray fluorescence instruments.

Finally a brief deascription of my own expertise in this area:

3. Brief CV for Dr. Fouts

a. Specific Work on lung

In 1970 I was appointed Chief of Pharmacology and Toxicology Branch at NIEHS and was in charge of both the inhalation toxicology program/facility and the program on pulmonary toxicity. I set up the laboratory research programs using isolated perfused lung and devised/adapted methods for isolating fresh lung cells of different types from rats, rabbits, and humans for study of lung functions as affected by different chemicals/pollutants.

b. Other

I published over 200 papers on various aspects of relating chemical metabolism to tissue (especially lung and liver) with specific damages by chemicals. At the University of Iowa, College of Medicine, I was Professor of Pharmacology (1957-1970) and Director of the Oakdale Toxicology Center (1967-1970). I was a member of the National Advisory Environmental Health Sciences Council and of its subcommittee on University-based Centers (1967-70). I was a member of the research programs planning Task Forces I and II of NIEHS in 1968 and 1976 (chairman of committees on pharmacology/toxicology--making plans for the new NIEHS programs in research). Chief of PTB/NIEHS (1970-1982); Acting Chief Biophysics, LOFT, PK.NIEHS (1976-1978). Scientific Director of NIEHS Intramural program in 1976-78. Present Position: Senior Scientific Advisor to the Director of NIEHS. Helped draft the description of research needs for the Request for Applications of the new NIEHS Superfund Research Program. Organizer of the September 1987 Acid Aerosols Health Effects conference.

4. List of Attachments/Brief Description of Contents

a. March 29, 1989 memo from Dr. Fouts to Miriam Devis—describes NIEHS-supported research results on health effects of acid rain

b. Dr. Morton Lippmann's summary of the NIEHS-sponsored conference on the Health Effects of Acid Aerosols

c. Dr. Kathryn Mahaffey's summaries of two recent NIEHS -sponsored conferences on the health effects of lead

    (1). "Advances in Lead Research: Implications for Environmental Health"—a conference at NIEHS, Jan. 16-18, 1989, to consider the newest research results showing health effects at very low lead exposures (previously considered "safe")

    (2). "Lead in Bone: Implications for Dosimetry and Toxicology"—a conference held at Columbia, MD, March 13-16, 1989, to consider the use/accuracy/adequacy of different methods for non-invasively measuring lead stores in humans

d. Lists of some current NIEHS-supported research/grants/contracts in air pollutant health effects

    (1). NIEHS grants for University-based Research on Air Pollution

    (2). NIEHS Intramural Research Studies into the Health Effects of Air Pollution

    (3). NIEHS Contracts for Toxicologic Studies of Air Pollutants

e. A description of two National Toxicology Program/NIEHS-supported ongoing studies on health effects of ozone

f. Brief descriptions of the "6 and 24 Cities" Studies by Harvard University—health effects of air pollution

Senator **Bingaman**. Thank you, Dr. Fouts.

Our second witness is Dr. John Spengler, who is a professor of Environmental Health at the Department of Environment Science and Physiology at the Harvard School of Public Health. We are very pleased to have you here in Albuquerque to give us your views.

STATEMENT OF DR. JOHN D. SPENGLER, PROFESSOR OF ENVIRONMENTAL HEALTH, DEPARTMENT OF ENVIRONMENTAL SCIENCE AND PHYSIOLOGY, HARVARD SCHOOL OF PUBLIC HEALTH

Dr. **Spengler**. Thank you, Senators, for inviting me and having this hearing.

In the interest of time, I will just summarize the highlights of my written testimony and refer to several figures that I hope you have in front of you. I will summarize those documents in my testimony.

Let me just say by introduction myself and my colleagues at Harvard University have been involved in air pollution health research for a number of years, supported by the National Institute of Environmental Health Sciences, the Environmental Protection Agency, the Electric Power Research Institute, the Health Effects Institute.

These studies have involved looking at the community air pollution health effects in six cities around the country involving children, 18,000 children for long periods of time; 10,000 adults have been tracked in this study. We are currently doing a collaborative effort with Health and Welfare of Canada. 24 cities involved in this. Specifically directed at assessing the effects on children of pollutants, such as ozone and the acid particles and acid gases. We had another study on toxic air emissions and the health effects of those in children and adults in West Virginia.

Here in Albuquerque, collaboration with Dr. Jonathan Samet at the University of New Mexico, and that is a study examining infant respiratory infections and their exposure to nitrogen dioxide. That nitrogen dioxide is primarily from indoor environments, although contributed in part from the outdoor environment.

Now, I think this is very appropriate time, 1989, to be examining the Clean Air Act of 1970; 20 years have gone by. We can ask several questions. What is the status of the air quality of our nation? And do we have demonstrated proof that the health of our population had been improved? I think we can also address what are the current emerging issues that we did not recognize 20 years ago that are potential health concerns of today and tomorrow. What are our effective strategies to pursue?

Figure 1 illustrates that indeed we have had tremendous progress in clean air. We are very much off because of the Clean Air Act. Sulfur dioxide particles, lead are all greatly reduced. Our nation's air is vastly improved by those criteria pollutants measured outdoors. This is a figure that is from the EPA trends document that indicates what they project as the population of the U.S. still might be experiencing living in an area that violates standards. So for carbon monoxide almost 30 million people still live in an area that do exceed the standard. Not that they themselves are seeing those exposures, but the levels are being exceeded, the national standard for carbon monoxide. But lead is greatly reduced. Particles in SO_2 are greatly reduced.

But look at the other pollutants, nitrogen dioxide and ozone, and this issue has gotten much, much worse. The next figure shows the trends in ozone in 1988 was—our nation saw ozone levels that were higher than any other time in this decade. Higher than 1983 when there was the previous high. It is projected that last summer 150 million people had the potential of seeing the ozone levels that exceeded our standards. So that is one pollutant that has gotten worse rather than gotten better.

If you look at other issues, and the question: Can we judge the health of our nation by looking at these ambient standards? In part you cannot, because there is substantial documentation that indoor sources, combustion products, biologicals, organic materials, fibers are all contributing to the fact that indoor air pollution is much greater than outdoor pollutants for some pollutants; not all but for some pollutants.

This tells us that we must fold this into our judgment as to how to interpret these ambient air quality levels, and how to measure these. It is clear that these levels due to gas combustion, for instance, can lead to a substantial portion of our population exceeding our national standards well beyond what EPA has indicated. They say possibly 7 million people that live in Los Angeles are seeing areas that are exceeding our standards, but that is not true. It is illustrated in the next two figures, figure 3 and figure 4, that measurments made inside people's homes, where they spend 90 percent of their time, due to these sources indoors for nitrogen dioxide, carbon monoxide shift their exposure range.

Even though you might be living in an urban area that meets the Federal standards, that does not necessarily mean that you yourself, your family, and other people in that population are protected against high levels of air pollution. That is not the case. That is even illustrated I think more dramatically in figures 5 and 6.

I am running out of time before I really hit the main point of what I wanted to say.

Senator BINGAMAN. Go ahead and give us your main point. We hate for you to come from Boston and miss your main point.

Dr. SPENGLER. Figure 5 and figure 6 illustrate the contrast in the emissions for benzene and emissions for tetrachloroethylene. This is, again, a tremendous contrast between what we have standards in for emission sources for these pollutants outdoors and what EPA personal exposure studies are telling us of where people really get exposed, and what are those sources that contribute to their exposures.

For benzene, for example, it shows that automobiles contribute 82 percent of the emissions. Industry contributes 14 percent of the emissions. But if you look at what people really are esposed to, cigarettes, either directly or passively, automobiles that air emissions penetrate inside our house or in the captive process of driving or commuting, we see much higher levels. Benzene levels in our homes, tetrachloroethylene levels in our homes are contributing substantially to our exposure. That must mean we have to reconsider strategies to protect the public health, vis-a-vis what sources we want to control and in what locations we want to control them.

Let me conclude by talking about pollutants that we now see are very much a concern for the future. We have to now consider sulfur dioxide and nitrogen dioxide emissions once again. These emissions lead to the formation of acid vapors and acid particles in the air. I think we also have to contrast where these sources are coming from. Sulfur dioxide, 85 percent of those emissions come from elevated sources, 120 feet above the surface. But nitrogen dioxide, above two-thirds of those emissions come within 120 feet of the surface. So we have a different source profile for these two precursors to acid vapors and acid particles.

For the last 10 years the National Acid Deposition Program has spent about half a billion dollars researching the transformation of these gases into acid rain and acid deposition, focusing solely on the ecological effects. Only now are we fully coming to recognize that you do not have to be concerned just about what falls out of the sky in terms of acid rain or acid deposition. That you, everyone of us, has the potential of inhaling these acid species. And the evidence from animal studies, chamber studies, controlled studies on human beings and epidemiology strongly suggest that there are damages to the respiratory system due to inhalation of these acid species.

Our own study on six-city, which is in part illustrated in figure 7 and figure 8—figure 7 is the daily acid concentration measured in six cities across the United States, showing that primarily in these cities now, summertime phenomenon, and you can see it increasing in summer months, that you see very sharp peaks in their daily acid concentration.

But this is only half the picture. This is the Eastern image. The Eastern image is dominated by the particles. The Western image will be dominated by the noxious inversion to nitrous acid and nitric acid.

There is evidence out of our six-city study that we are just concluding, as shown on figure 8. We have plotted on one side of this figure the prevalence of bronchitis in children across the six communities indicated by the letter symbol ranging from about 3½ percent of the children having chronic bronchitis up to 10 percent of the children living in those community having chronic bronchitis. That is a plot of the prevalence of bronchitis versus particle concentration, PM15, when we substitute the measurement of hydrogen ion.

In other words, we really have to try to understand the chemical composition of those particles and use the chemical species as the component, and we have a much better and stronger predictor of what might be the really underlying culprit. In other words, that the high levels in Stubbenville, the high levels of bronchitis in Kingston, Tennessee, a rural community, are strongly predicted by the hydrogen ion content of the particles that are measured in those two communities.

In other studies that look at mortality rates in about 100 cities across the country—we addressed those mortality rates against air pollution and other controlling factors—consistently indicate that 4 to 8 percent of the mortality in these cities is being associated with the sulfur compound, which we would infer is the surrogate for the acid species. So we might be paying a very high price in this country in terms of public health, even though we are meeting our SO_2 standards, meeting our NO_2 standards. The price we are paying is the conversion products, the acid rebirth, the acid species that are formed from these compounds, leading to the high exposures.

Let me just say four points on what I think are changes that might be needed for the Clean Air Act amendments, if it is going to be revised. I think, repeating, today's concentrations we may be paying a substantial price in terms of human health effects unless there is a considerable reduction in NO_X and SO_2 emissions. We will continue to expose millions of people to acid air pollution.

Because of the human exposures from vehicle emissions that are 50 to 100 percent higher while we are inside those vehicles commuting, we have to continue to pay attention to the further reduction of the mobile source of emissions.

Bacause of volatile organic compounds that can be formed, irritating aldehydes, acids, mutagenic compounds, that are possibly associated with alternative fuels, this has to be carefully evaluated before people have widespread fuel substitution programs.

Because benzene is ubiquitous in our air, the regulation of benzene and other toxic substances under section 112 of the Clean Air Act, as an emissions standard, is not going to work. It is impractical, and it is ineffective of protecting public health. I strongly urge that benzene and other volatile organic compounds be considered as criteria pollutants, just like we have for particles of lead, sulfur dioxide and ozone.

I think EPA's process of evaluating health effects in establishing standards is exceedingly long, and we need to accelerate this process. Fund critical research and setting interim guidelines should be promoted.

And finally, because human exposures can occur from outdoor sources as well as indoor sources, amendments to the Clean Air Act should be explicit in directing EPA and other agencies to consider indoor air pollution in its risk assessment, standard setting and control strategies.

[The prepared statement of Dr. Spengler follows:]

TESTIMONY: PROF. JOHN D. SPENGLER
HARVARD UNIVERSITY
SCHOOL OF PUBLIC HEALTH
BOSTON, MA 02115

BEFORE: UNITED STATES SENATE
SUBCOMMITTEE ON MINERAL RESOURCES DEVELOPMENT & PRODUCTION
OF THE SENATE ENERGY AND NATURAL RESOURCES COMMITTEE
ALBUQUERQUE, NM MAY 25, 1989

I AM JOHN D. SPENGLER, PROF. OF ENVIRONMENTAL HEALTH AND DIRECTOR OF THE PHYSICAL SCIENCE AND ENGINEERING PROGRAM, DEPT. OF ENVIRONMENTAL SCIENCE AND PHYSIOLOGY, HARVARD UNIVERSITY, SCHOOL OF PUBLIC HEALTH IN BOSTON, MASSACHUSETTS. SINCE 1974, WE HAVE BEEN INVOLVED IN A LONG-TERM PROSPECTIVE AIR POLLUTION RESPIRATORY HEALTH STUDY. THIS STUDY HAS TRACKED THE RESPIRATORY HEALTH AND LUNG FUNCTIONS OF SOME 18,000 CHILDREN AND 10,000 ADULTS LIVING IN SIX U.S. COMMUNITIES. THIS STUDY HAS BEEN FUNDED BY THE NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES WITH ADDITIONAL SUPPORT FROM THE ENVIRONMENTAL PROTECTION AGENCY AND THE ELECTRIC POWER RESEARCH INSTITUTE. THIS STUDY, REFERRED TO AS THE HARVARD 6-CITIES STUDY, HAS BEEN INVESTIGATING THE HEALTH EFFECTS OF NITROGEN DIOXIDE, SULFUR DIOXIDE, PARTICLES, OZONE, TOBACCO SMOKE, AND MICROBIOLOGICAL CONTAMINANTS FOR OUTDOOR, INDOOR, AND PERSONAL EXPOSURES. RECENTLY WE HAVE BEEN ENGAGED IN A JOINT U.S.-CANADIAN STUDY, ALSO FUNDED BY NIEHS, INVESTIGATING RESPIRATORY HEALTH IN CHILDREN LIVING IN 24 U.S. AND CANADIAN COMMUNITIES. IN THIS STUDY, WE ARE FOCUSING ON THE CHRONIC EFFECTS ASSOCIATED WITH OZONE AND ACIDIC AIR POLLUTANTS. THIS STUDY IS REFERRED TO AS THE ACID HEALTH STUDY. THROUGH OUR RESEARCH WE ARE DEVELOPING THE VIEW THAT LARGE SEGMENTS OF OUR POPULATION ARE EXPOSED TO ACIDIC VAPORS AND GASES THAT ARE FORMED IN THE ATMOSPHERE FROM

POWER PLANT, INDUSTRIAL, AND AUTOMOBILE EMISSIONS. THESE LEAD TO THE FORMATION OF NITROUS AND NITRIC ACID VAPORS AND PARTICULATE SULFURIC ACID SPECIES. I WILL DISCUSS THIS IN MORE DETAIL LATER.

IN ADDITION TO THESE STUDIES, WE ARE CURRENTLY COLLABORATING WITH DR. JONATHAN SAMET, AT THE UNIVERSITY OF NEW MEXICO MEDICAL SCHOOL, ON A LARGE SCALE INVESTIGATION OF INFANT MORBIDITY AND NITROGEN DIOXIDE EXPOSURES. THIS STUDY WILL INVOLVE 1,000 INFANTS LIVING IN ALBUQUERQUE, NEW MEXICO. NO_2 EXPOSURES ARE A RESULT OF OUTDOOR NO_2 EXHAUST FROM AUTOMOBILES AND INDOOR EMISSIONS FROM UNVENTED GAS STOVES AND HEATERS.

OVER THE PAST DECADE I HAVE SERVED AS CHAIRMAN OR MEMBER OF SEVERAL NATIONAL ACADEMY OF SCIENCE AND EPA ADVISORY COMMITTEES. THESE COMMITTEES ARE LISTED IN MY CURRICULUM VITAE THAT WAS GIVEN TO SENATOR BINGAMAN'S STAFF.

WITH A RETROSPECTIVE LOOK ON THE CLEAN AIR ACT AMENDMENTS OF 1970, WE SHOULD EXAMINE A FEW FUNDAMENTAL QUESTIONS:

1. IS THERE EVIDENCE FOR IMPROVED ENVIRONMENTAL QUALITY?

2. HAS THE PUBLIC HEALTH OF OUR NATION BEEN IMPROVED?

3. WITH CURRENT KNOWLEDGE, WHAT ARE THE CONTAMINANTS AND SOURCES OF CONCERN?

4. ARE THERE MORE EFFECTIVE MANAGEMENT STRATEGIES FOR IMPROVING OUR

NATION'S AIR QUALITY AND REDUCING RISK TO THE PUBLIC?

THESE ARE BROAD AND COMPLICATED ISSUES THAT I RECOGNIZE WILL BE SCRUTINIZED BY CONGRESS OVER THE NEXT SEVERAL MONTHS. I APPRECIATE THAT THIS COMMITTEE IS SEEKING A PERSPECTIVE FROM THE ENVIRONMENTAL HEALTH RESEARCH COMMUNITY.

IMPROVED AIR QUALITY

THERE IS NO DOUBT THAT THE QUALITY OF OUR NATION'S AIR HAS IMPROVED FOR SEVERAL CRITERIA POLLUTANTS AS MEASURED IN THE OUTDOOR AIR. GONE ARE THE DAYS WHEN THE AIR IN MANY OF OUR URBAN AREAS WAS FULL OF SULFUR DIOXIDE AND SOOT. CONTROLS ON STATIONARY SOURCES, REDUCTION IN OUR NATION'S MANUFACTURING BASE, AND DISPLACEMENT OF ELECTRICAL POWER GENERATION TO RURAL LOCATIONS HAS MADE OUR URBAN AREAS APPEAR TO BE MORE LIVABLE. INVESTMENTS IN URBAN AREAS OVER THE PAST 15 YEARS, IN PART, REFLECT THE IMPROVING ENVIRONMENTAL QUALITY.

REDUCTION IN TAILPIPE EMISSIONS AND BETTER FUEL ECONOMY HAVE HAD A MAJOR IMPACT IN LOWERING CO CONCENTRATIONS. CURRENTLY, THE EPA ESTIMATES THAT 29 MILLION PEOPLE LIVE IN AREAS WHERE CO IS STILL IN VIOLATION. ONLY A FEW LOCATIONS IN LOS ANGELES ARE IN VIOLATION OF NO_2 STANDARDS. RESTRICTIONS IN GASOLINE LEAD CONTENT HAS ALSO PRODUCED SUBSTANTIAL REDUCTIONS IN AMBIENT LEAD CONCENTRATIONS. SEE FIGURE 1.

HOWEVER, EVEN IF THESE INDICATORS ARE ENCOURAGING WE SHOULD BE MINDFUL THAT THERE ARE WIDESPREAD VIOLATIONS OF OUR AMBIENT OZONE STANDARD. IN 1987, THE EPA ESTIMATES 89 MILLION PEOPLE WILL BE BREATHING AIR WHERE THE OZONE CONTENT EXCEEDS ESTABLISHED HEALTH STANDARDS. NEW EVIDENCE SUGGESTS THAT

RESPIRATORY EFFECTS OCCUR AT LEVELS BELOW 120 PPB. OZONE LEVELS RECORDED DURING THE SUMMER OF 1988 WERE THE HIGHEST IN THIS DECADE. OZONE IS NOT JUST A CALIFORNIA PROBLEM. WESTERN URBAN AREAS AND ALMOST ALL OF THE POPULATED EASTERN THIRD OF THE U.S. EXPERIENCES OZONE VIOLATION. DURING THE SUMMER OF 1988, AN ESTIMATED 150 MILLION AMERICANS HAD THE POTENTIAL OF EXPERIENCING OZONE LEVELS VIOLATING STANDARDS. SEE FIGURE 2.

WITHOUT FURTHER REDUCTIONS IN NO_x EMISSIONS, WE WILL EXPERIENCE INCREASING NO_2 CONCENTRATIONS IN URBAN AREAS. PROJECTED INCREASES IN ELECTRICAL POWER GENERATION FROM FOSSIL FUELS AND GROWTH IN VEHICLE MILES TRAVELED WILL INCREASE NO_x EMISSIONS. TWO THIRDS OF ALL NO_x EMISSIONS ARE RELEASED FROM SOURCES WITHIN 120 FEET OF THE GROUND AND MOSTLY IN URBAN AREA. WHILE NO NEW EVIDENCE WOULD SUPPORT LOWERING THE ANNUAL HEALTH STANDARDS BELOW 53 PPB (100 $\mu g/m^3$), THE WORLD HEALTH ORGANIZATION HAS RECOMMENDED SHORT-TERM HEALTH STANDARDS AS EUROPEAN AIR QUALITY GUIDELINES. CALIFORNIA HAS PROMULGATED A 1-HOUR NO_2 AIR QUALITY STANDARD. MANY URBAN AREAS ARE EXCEEDING THESE SHORT-TERM GUIDELINES. WHEN CONSIDERING THE ADDITIONAL INDOOR EXPOSURES TO NO_2, WE CAN SAY UNEQUIVOCALLY THAT MILLIONS OF AMERICANS ARE EXPOSED TO NO_2 CONCENTRATIONS THAT EXCEED BOTH U.S. AMBIENT STANDARDS AND WHO EUROPEAN GUIDELINES. FIGURE 3.

AMBIENT AIR QUALITY AND PUBLIC HEALTH

EXPOSURES TO AIR POLLUTION FROM INDOOR SOURCES CHALLENGES THE BASIC ASSUMPTIONS THAT MEETING OUTDOOR AIR QUALITY STANDARDS PROTECTS THE PUBLIC HEALTH. THAT ASSUMPTION IS LEAST APPROPRIATE WHEN SOURCES OF COMBUSTION

INDOORS RESULTS IN ELEVATED CONCENTRATIONS OF CO, NO_2, ORGANIC VAPORS AND PARTICLES, AMONG OTHER CONTAMINANTS. KEROSENE, TOBACCO, WOOD STOVES, AND GAS APPLIANCES ARE EXAMPLES OF INDOOR COMBUSTION SOURCES. IN THE U.S. ABOUT 50% OF THE RESIDENCES HAVE GAS COOKING FACILITIES. THEREFORE, IT IS NOT SURPRISING TO FIND THAT THESE INDOOR SOURCES CAN DOMINATE EXPOSURES. THIS DOES NOT, HOWEVER, LEAD TO THE SIMPLISTIC VIEW THAT WE SHOULD CONTROL OUTDOOR SOURCES LESS. FIRST, OUTDOOR AIR PENETRATES INTO OUR HOMES, OFFICES, SCHOOLS, HOSPITALS, AND ARENAS. WHERE OUTDOOR LEVELS OF UNREACTIVE GASES ARE HIGH, INDOOR AIR WILL ALSO BE AFFECTED. SECOND, PEOPLE DO SPEND TIME OUTDOORS RANGING FROM MINUTES TO HOURS. OFTEN PEOPLE ARE OUTDOORS WHEN THE LEVELS ARE THE HIGHEST.

WE SHOULD CONSIDER INDOOR SOURCES AND EXPOSURES WHEN DEVISING COST-EFFECTIVE MITIGATION STRATEGIES. FOR EXAMPLE, ELIMINATING PILOT LIGHTS ON GAS RANGES MAY NOT ONLY SAVE ENERGY BUT WILL RESULT IN A VERY SIGNIFICANT REDUCTION IN CHRONIC EXPOSURES TO NO_2. FIGURE 4.

WE ARE LEARNING THAT EXPOSURES TO MUTAGENIC, CARCINOGENIC AND IRRITATING ORGANIC VAPORS ARE OFTEN SUBSTANTIALLY HIGHER INSIDE HOMES, OFFICE AND AUTOMOBILES THAN THE SIMULTANEOUS OUTDOOR MEASUREMENTS (EPA'S VOC TEAM STUDIES). IN FACT, GASOLINE EVAPORATIVE EMISSION OF BENZENE AND ETHYLBENZENE, AMONG OTHERS, ARE NOTICEABLY HIGHER INSIDE HOMES THAT HAVE ATTACHED GARAGES. FIGURE 5 CONTRASTS AIR EMISSIONS FOR BENZENE AND THE ESTIMATED ACTUAL EXPOSURE DERIVED FROM THE EPA'S VOC TEAM STUDIES. DIRECT EXPOSURE FROM INDUSTRY IS A VERY SMALL FRACTION OF THE BENZENE EXPERIENCED BY MOST AMERICANS. SIMILARLY, FOR TETRACHLORETHYLENE PERSONAL HABITS OF DRY CLEANING CLOTHES AND VISITING

THE CLEANERS ARE FAR MORE IMPORTANT THAN DIRECT EXPOSURES TO INDUSTRIAL EMISSIONS. SEE FIGURE 6.

THE MESSAGE FROM THE EMERGING DATA BASE ON INDOOR AND HUMAN EXPOSURE STUDIES IS CLEAR. WE CAN NO LONGER FORMULATE OUR ENVIRONMENTAL REGULATORY STRATEGIES BASED ON A SINGLE MEDIUM (AIR VERSUS WATER) OR SINGLE LOCATION (AMBIENT VERSUS INDOOR). EFFECTIVE PUBLIC POLICY MUST CONSIDER INDOOR ENVIRONMENTS.

ACID EXPOSURES

UNLIKE NO_x, SO_2 EMISSIONS ARE PREDOMINATELY FROM ELEVATED SOURCES; 85% ARE GREATER THAN 120 FEET ABOVE THE SURFACE. ABOUT 80% OF THE SO_2 EMISSIONS COME FROM THE 31 STATES BORDERING OR EAST OF THE MISSISSIPPI RIVER. EMISSIONS OF NO_x AND SO_2 LEAD TO THE FORMATION OF ACIDIC VAPORS AND PARTICLES. HISTORIC MEASUREMENTS OF ACIDIC SPECIES ARE INSUFFICIENT TO DEVELOP TRENDS, BUT BASED ON EMISSIONS AND VISIBILITY DATA, ATMOSPHERIC ACIDITY HAS PROBABLY BEEN UNCHANGED. BECAUSE OF SHIFTS IN EMISSION PATTERNS, PARTICLE ACID EXPOSURES IN THE U.S. ARE PREDOMINATELY A SPRING AND SUMMER PHENOMENON. FIGURE 7 SHOWS DAILY PARTICLE ACID MEASUREMENTS MADE IN 6 U.S. CITIES.

BASED ON ANIMAL, CLINICAL, AND LIMITED EPIDEMIOLOGIC DATA WE SHOULD BE CONCERNED THAT ACID EXPOSURES MAY BE THE REAL "CULPRIT" CAUSING HEALTH EFFECTS. CHAMBER STUDIES SUGGEST THAT ALTERATIONS IN LUNG PERFORMANCE AND PARTICLE CLEARANCE ARE CAUSED BY INHALATION OF ACIDIC SPECIES. ANIMAL STUDIES CLEARLY SHOW CELL STRUCTURE DAMAGE DUE TO ACID EXPOSURES. OUR OWN 6-CITIES

STUDY SUGGESTS THAT BRONCHITIS RATES ARE MORE STRONGLY ASSOCIATED WITH PARTICLE ACIDITY THAN WITH ANY OTHER MEASURE OF AIR POLLUTION. FIGURE 8 SHOWS THE RELATIONSHIP BETWEEN BRONCHITIS RATES FOR CHILDREN IN 6 CITIES AND AMBIENT CONCENTRATIONS OF PARTICLES LESS THAN 15 μm. WHEN AMBIENT PARTICLE ACID IS USED AS THE MEASURE OF EXPOSURE THE RESULTS SUGGEST A BETTER RELATIONSHIP AT THE HIGHER END. ACIDITY WAS DETERMINED ONLY FOR THE PARTICLES AND NOT VAPOR-PHASE ACIDITY.

THE STUDY OF URBAN MORTALITY RATES VERSUS AIR POLLUTION, CONDUCTED BY MY COLLEAGUES OZKAYNAK AND THURSTON, PROVIDES SUPPORTING EVIDENCE THAT PARTICLE SULFUR (A LIKELY SURROGATE FOR ACIDITY) IS ASSOCIATED WITH PREMATURE DEATHS, EVEN AT THE CONCENTRATIONS WE ARE CURRRENTLY EXPERIENCING. THE ASSOCIATIONS THAT THEIR STUDY MAKES BETWEEN MORTALITY RATES IN THE U.S AND VARIOUS INDICATORS OF POLLUTION ARE WEAK FOR TOTAL SUSPENDED PARTICLES BUT BECOMES SIGNIFICANTLY STRONGER WHEN MEASURES OF RESPIRABLE SIZE PARTICLES AND SULFUR ARE USED.

RECENT STUDIES BY JANE KOENIG, AT THE UNIVERSITY OF WASHINGTON, ON ADOLESCENT ASTHMATICS SUGGEST THAT NITRIC ACID EXPOSURES CAN CAUSE CHANGES IN PULMONARY PERFORMANCE SIMILAR TO SULFURIC ACID.

WE ARE NOW FINDING THAT NO_2 CAN REACT ON INTERIOR SURFACES AND FORM NITROUS ACID. WHEN HOMES HAVE UNVENTED GAS OR KEROSENE COMBUSTION, NITROUS ACID CONCENTRATIONS CAN BE 25 TO 50 TIMES HIGHER THAN WHAT IS MEASURED OUTDOORS.

THE PRECURSORS TO NITROUS AND NITRIC ACID ARE AUTOMOBILE AND POWER PLANT NO_x EMISSIONS. THE PRECURSORS TO ACID PARTICLE FORMATION ARE SO_2 EMISSIONS FROM FOSSIL FUEL COMBUSTION. THE FORMATION OF FORMIC ACID AND OTHER ORGANIC ACIDS ARE ALSO FROM AUTO EXHAUST AND GASOLINE EVAPORATION. WE CAN NOT BE COMPLACENT. JUST BECAUSE THERE IS COMPLIANCE WITH SO_2 AND NO_2 STANDARDS DOES NOT IMPLY THAT A PUBLIC HEALTH PROBLEM DOES NOT EXIST--THE MOUNTING EVIDENCE ON THE HEALTH EFFECTS ASSOCIATED WITH ACIDIC EXPOSURES SUGGESTS JUST THE OPPOSITE. AT TODAY'S CONCENTRATIONS WE MAY BE PAYING A VERY SUBSTANTIAL PRICE IN TERMS OF HUMAN HEALTH. UNLESS THERE ARE CONSIDERABLE REDUCTION OF NO_x AND SO_2 EMISSIONS, WE WILL CONTINUE TO EXPOSE MILLIONS OF PEOPLE TO ACID AIR POLLUTION.

MODERNIZING THE CLEAN AIR ACT

IT IS APPROPRIATE TO EVALUATE THE EFFECTIVENESS OF THE CLEAN AIR ACT. I WILL OFFER A FEW OBSERVATIONS.

1. BECAUSE ACTUAL HUMAN EXPOSURES TO VEHICLE EMISSIONS ARE 50% TO 100% HIGHER WHILE DRIVING AS COMPARED TO MEASUREMENTS AT FIXED LOCATION OUTDOOR MONITORS, THERE IS A NEED TO FURTHER REDUCE MOBILE SOURCE EMISSIONS.

2. BECAUSE VOLATILE COMPONENTS OF FUELS CAN CONTRIBUTE TO THE FORMATION OF IRRITATING ALDEHYDES, ACIDS, AND MUTAGENIC/CARCINOGENIC COMPOUNDS, THE CURRENT AND FUTURE COMPOSITION OF GASOLINE MUST BE CAREFULLY EVALUATED.

3. BECAUSE BENZENE IS UBIQUITOUS IN AMBIENT AND INDOOR AIR, REGULATION UNDER SECTION 112 (HAZARDOUS AIR POLLUTANT EMISSIONS) IS IMPRACTICAL AND INEFFECTIVE IN PROTECTING PUBLIC HEALTH. BENZENE AND SEVERAL OTHER VOLATILE ORGANIC COMPOUNDS SHOULD BE CONSIDERED AS CRITERIA AIR POLLUTANTS.

4. BECAUSE THE EPA'S CURRENT PROCESS OF EVALUATING HEALTH AND EXPOSURE EVIDENCE FOR AIR POLLUTANTS IS EXCEEDINGLY LONG, A MECHANISM FOR ACCELERATING PROCEDURES, FUNDING CRITICAL RESEARCH AND SETTING INTERIM GUIDELINES SHOULD BE PROMOTED.

5. BECAUSE POLLUTION IN INDOOR ENVIRONMENTS IS IMPORTANT TO TOTAL HUMAN EXPOSURES, AMENDMENTS TO THE CLEAN AIR ACT SHOULD EXPLICITLY DIRECT THE EPA AND OTHER AGENCIES TO CONSIDER INDOOR AIR IN ITS RESEARCH, RISK ASSESSMENT, STANDARD SETTING, AND CONTROL STRATEGIES.

FIGURES

1. Number of Persons Living in Counties with Air Quality Levels above the Primary National Ambient Air Quality Standards in 1987 (based on 1980 population data). From U.S. EPA, National Air Quality and Emission Trends Report, 1987, Office of Air Quality, Planning and Standards Monitoring and Reports Branch, Research Triangle Park, NC., EPA-450/4-89-001, March 1989.

2. Preliminary Estimate of the National Trend in the Composite Average of the Second Highest Daily Maximum 1-hour Ozone Concentrations, 1978-1988. From U.S. EPA 1987 Trends Report.

3. Cumulative Probablity Distributions for Nitrogen Dioxide Concentrations in Boston Residences. From P.B. Ryan et al., "The assessment of Human Exposure to Nitrogen Dioxide," 1989 International Gas Research Conference in Tokyo, Japan, November 6-9, 1989.

4. Cumulative Probability Distributions for Nitrogen Dioxide Concentrations for Pilot Light and Non-Pilot Light Homes. From P.B. Ryan et al.

5. Benzene, Emissions versus Exposures. L. Wallace, Personal Communication, EPA's VOC TEAM.

6. Tetrachloroethylene, Emissions versus Exposures. L. Wallace, Personal Communication, EPA's VOC TEAM.

7. Daily Acidity Concentrations: Hydrogen Ion and Equivalent H_2SO_4

8. 6-Cities Health Effects, Bronchitis vs. PM15

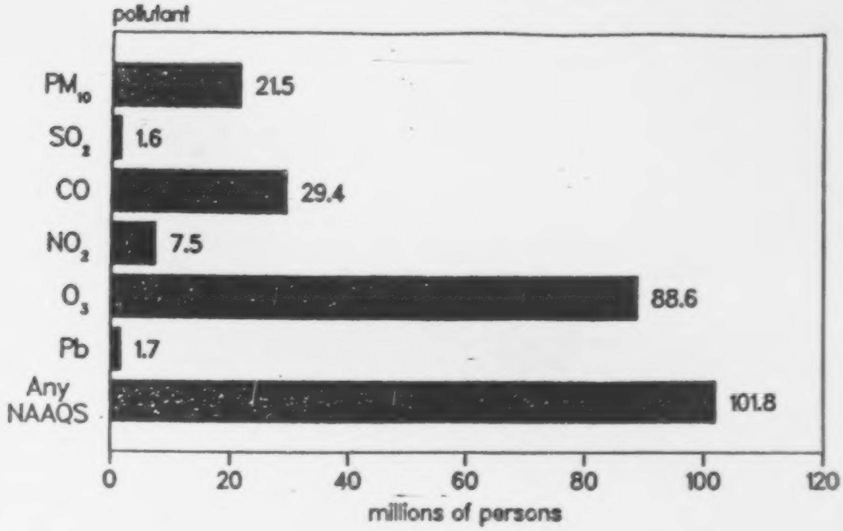


Figure 1 **Number of persons living in counties with air quality levels above the primary National Ambient Air Quality Standards in 1987 (based on 1980 population data).** From U.S. EPA, National Air Quality and Emission Trends Report, 1987, Office of Air Quality, Planning and Standards Monitoring and Reports Branch, Research Triangle Park, N.C., EPA-450/4-89-001, March 1989.

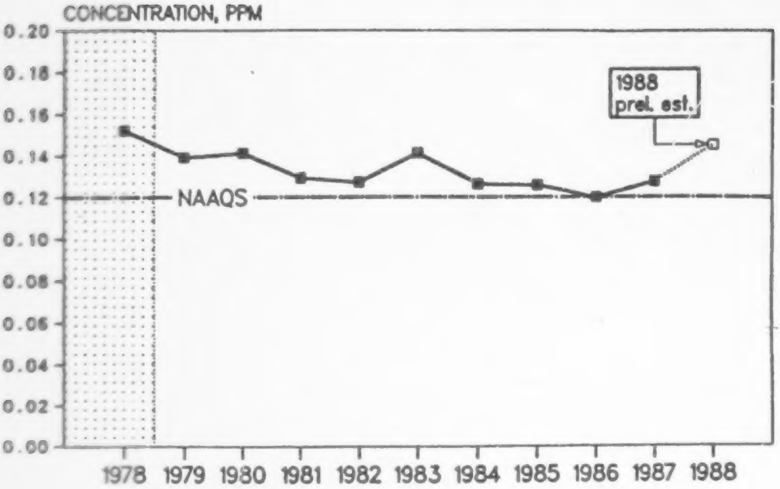


Figure 2 . **Preliminary estimate of the national trend in the composite average of the second highest daily maximum 1-hour ozone concentration, 1978-1988.**

From U.S. EPA, National Air Quality and Emission Trends Report, 1987, Office of Air Quality, Planning and Standards Monitoring and Reports Branch, Research Triangle Park, N.C., EPA-450/4-89-001, March 1989.

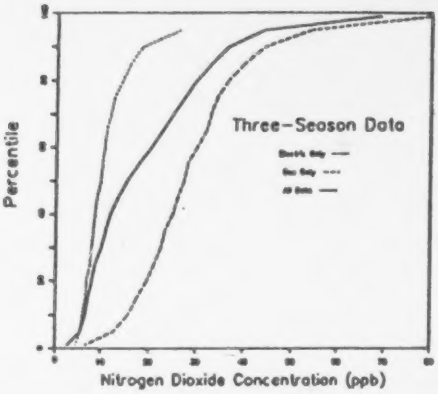
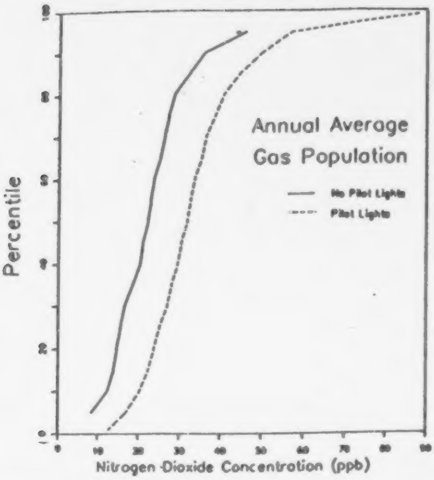


FIGURE 3 **CUMULATIVE PROBABILITY DISTRIBUTIONS FOR NITROGEN DIOXIDE CONCENTRATIONS IN BOSTON RESIDENCES.** From P.B. Ryan et al., "The assessment of human exposure to nitrogen dioxide," 1989 International Gas Research Conference in Tokyo, Japan, November 6-9, 1989.



FIGURF 4 CUMULATIVE PROBABILITY DISTRIBUTIONS FOR NITROGEN DIOXIDE CONCENTRATIONS FOR PILOT LIGHT AND NON-PILOT LIGHT HOMES

From P. B. Ryan et al., "The assessment of human exposure to nitrogen dioxide," 1989 International Gas Research Conference in Tokyo, Japan, November 6-9, 1989.

FIGURE 5

BENZENE

Emissions vs. Exposures

(L. Wallace, Personal Communication, EPA's VOC TEAM)

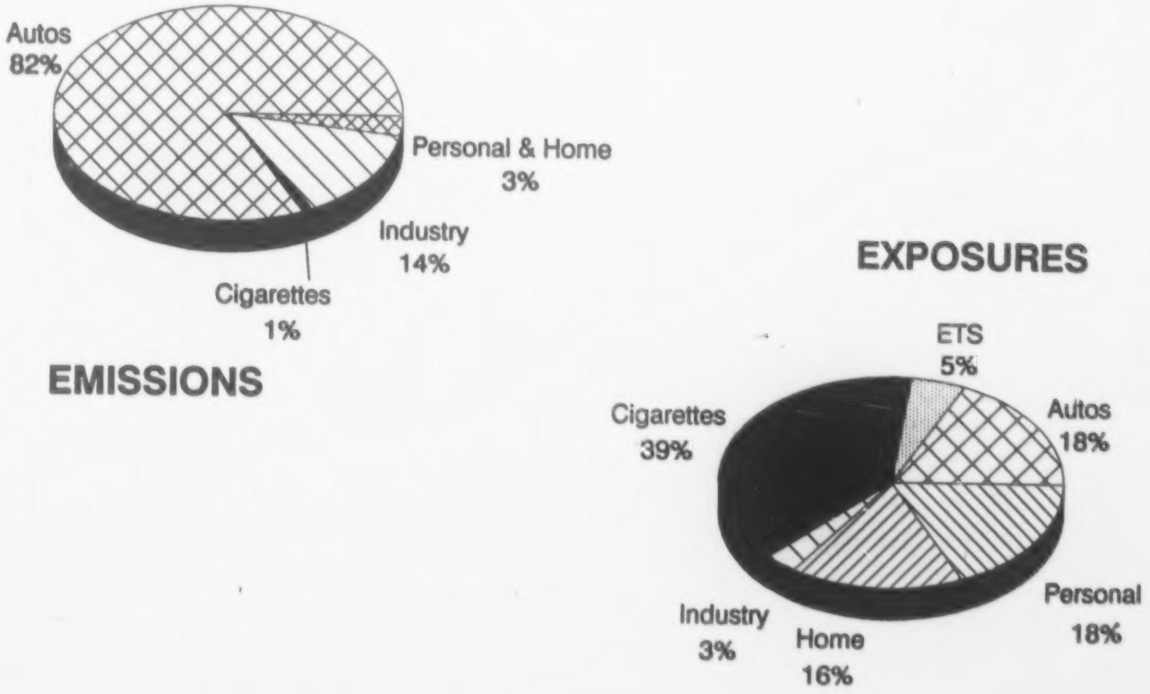


FIGURE 6

TETRACHLOROETHYLENE

Emissions vs. Exposures

(L. Wallace, Personal Communication, EPA's VOC TEAM)

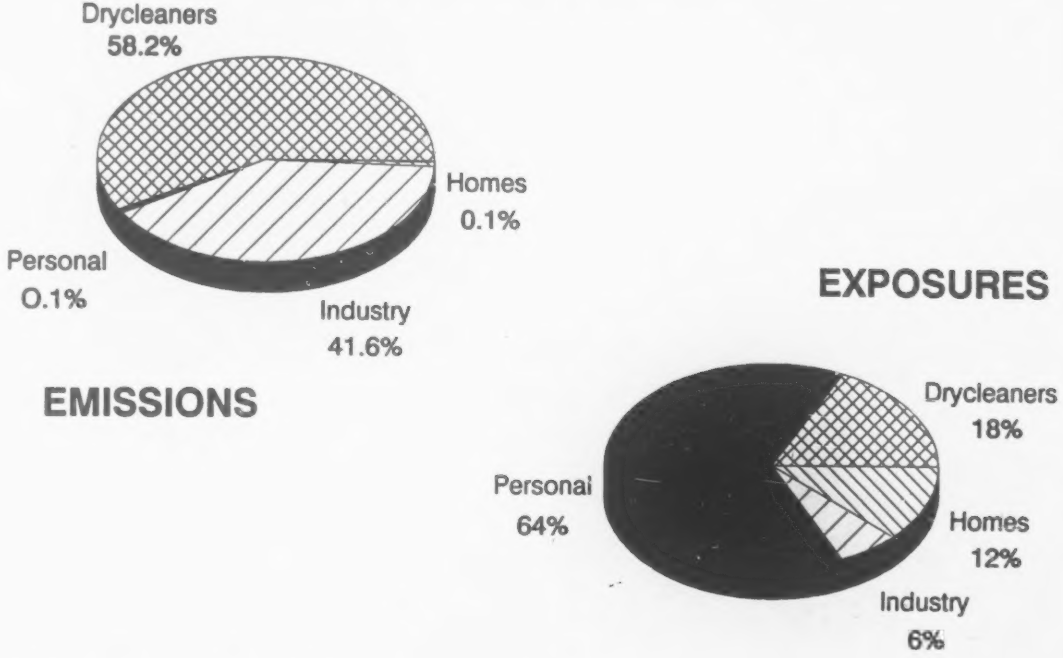
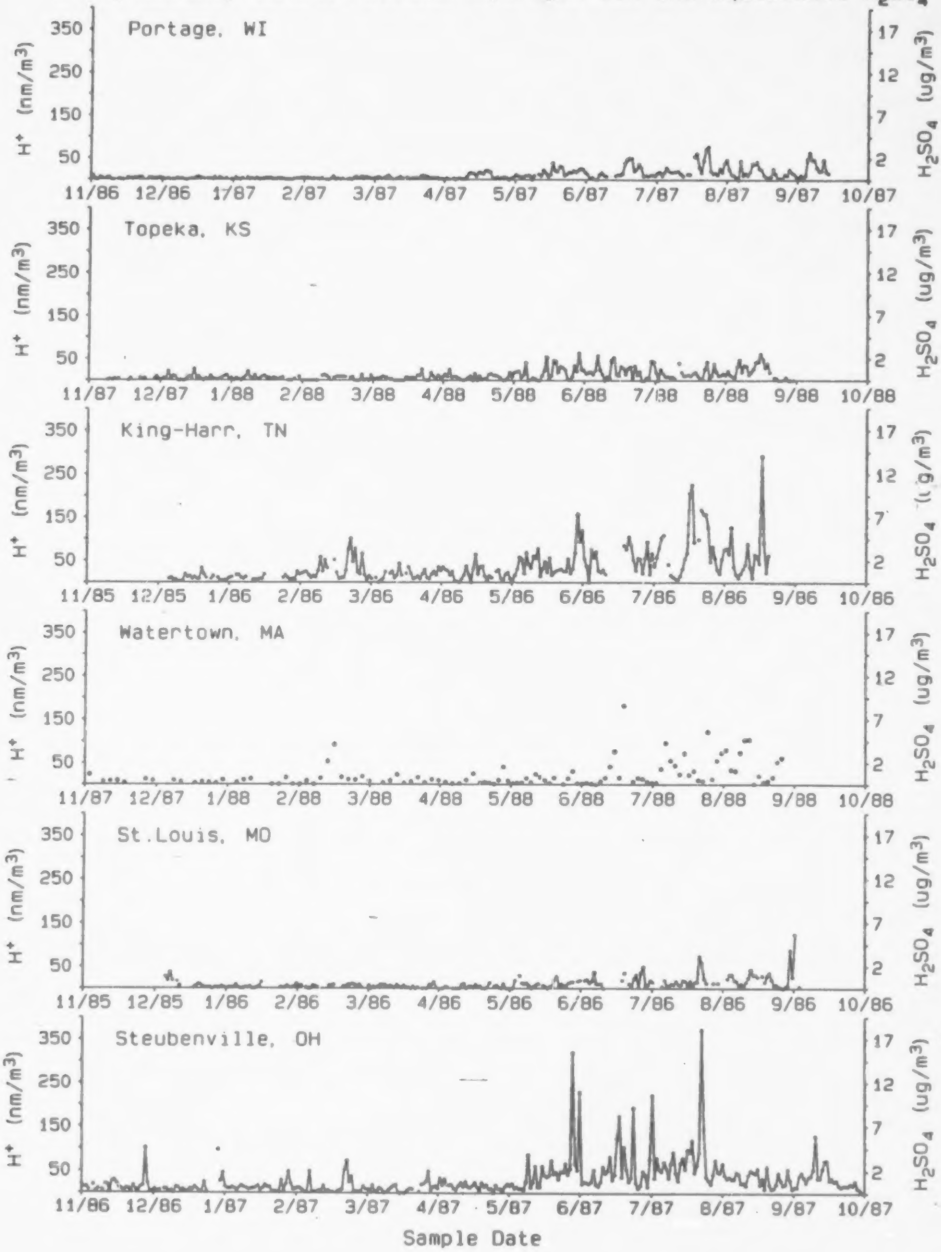


FIGURE 7

Daily Acidity Concentrations: Hydrogen Ion and Equivalent H_2SO_4



Portage, WI

Topeka, KS

King-Harr, TN

Watertown, MA

St.Louis, MO

Steubenville, OH

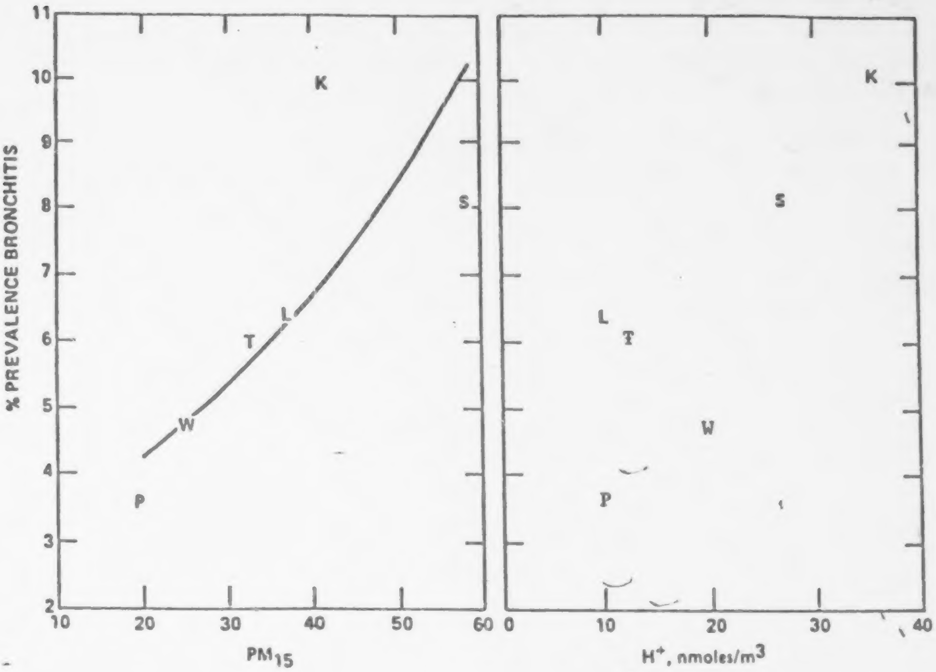


Figure 8 Bronchitis in the last year, children 10 to 12 years of age in six U.S. cities vs. particulate matter (PM15) concentrations. (P = Portage, WI; T = Topeka, KS; W = Watertown, MA; K = Kingston, TN; L = St. Louis, MO; S = Steubenville, OH. Bronchitis vs. annual averaged H^+, nmoles/m^3. After Speizer, 1989 (16), with Topeka H^+ concentrations added.

Senator **Bingaman**. Thank you very much.

Our third witness of this panel is Dr. Robert Bethel, who is with the National Jewish Center for Immunology and Respiratory Medicine in Denver. We are very pleased to have you here.

STATEMENT OF DR. ROBERT BETHEL, THE NATIONAL JEWISH CENTER FOR IMMUNOLOGY AND RESPIRATORY MEDICINE

Dr. **Bethel**. Thank you, Senator, and thank you for asking me to testify.

As you mentioned, I am a medical doctor and specialist in lung diseases at the National Jewish Center for Immunology and Respiratory Medicine at the University of Colorado in Denver. I see many patients who have asthma. In the past in conjunction with Drs. Dean Sheppard and Homer Boushey at the University of California, San Francisco, I conducted controlled trials on the effects of sulfur dioxide on persons who had asthma. Today I would like to speak on the health effects of sulfur dioxide on persons who have asthma and try to convince you that current air quality standards do not adequately protect asthmatics.

Sulfur dioxide, as you know, is released into the atmosphere by coal burning power plants, smelters, pulp and paper mills and coke plants. SO_2, in low concentrations, causes asthma attacks. Concentrations between 0.25 and 0.50 ppm regularly induce chest tightness in mild asthmatics who are exercising. The asthma attacks induced by sulfur dioxide are typical of other asthma attacks I see in my practice. Patients develop shortness of breath, chest tightness, and wheezing. Sometimes the chest tightness requires the use of medication. The increases in measured airway resistance induced by sulfur dioxide are significant. We found that mild asthmatics, breathing 0.5 ppm sulfur dioxide for five minutes, while performing moderately heavy exercise, increase their airway resistance an average of 238 percent. The maximal increase in this study was 656 percent. Exercise increases an asthmatic's sensitivity to sulfur dioxide by increasing the quantity of sulfur dioxide that is inhaled. Also, cold dry air, which is common in these mountain states in the winter, also increases an asthmatic's sensitivity to SO_2. SO_2 may interact with additional inhaled irritants as already has been mentioned. Although the mild asthmatics in the exposure studies that we performed had significant responses to SO_2, it is likely that persons who have more severe asthma get even greater responses to SO_2. In general, persons who have more severe asthma have greater bronchoconstrictor responses to inhaled irritants. Thus, low concentrations of ambient sulfur dioxide pose a significant risk to asthmatics.

Current air quality standards do not adequately protect asthmatics from the effects of SO_2. The current primary standards require that average SO_2 concentrations not exceed 0.14 ppm averaged over a 24-hour period on more than one day a year. Currently, there is no primary short term standard to protect the health of asthmatics. The consequences of the lack of a short term standard are that ambient SO_2 concentrations are allowed to be much higher during certain portions of the day if overall the average is less than 0.14 ppm. In fact, several SO_2-emitting facilities that meet current standards for SO_2 have been shown to cause transient SO_2 concentrations high enough to induce significant asthma attacks.

Last year the Environmental Protection Agency recommended that the current standards for SO_2 not be changed. In reaching this decision I think they accepted the premise that not all asthmatics need to be protected from the harmful effects of sulfur dioxide. They also suggested that medications and inactivity would prevent many asthma attacks in asthmatics exposed to toxic concentrations of SO_2.

I question whether the Environmental Protection Agency, in making this decision, correctly interpreted the will of Congress to protect the population. As a physician, I think that all persons have the right to breathe air that is not harmful to them, even if the reaction caused is transient and reversible. In regard to the use of prophylactic medications to prevent sulfur-dioxide-induced asthma, the use of medications is not likely to be entirely effective. More over, asthmatics should not have to use medications or have to tolerate their adverse effects to safely breathe ambient air. Similarly, inactivity is unlikely to prevent SO_2-induced asthma, simply because persons will not remain inactive. Many asthmatics are children, and children will not remain inactive. Many adults will maintain their normal activity regardless of the consequences. For other health reasons, asthmatics should not have to lead a sedentary life. Thus, there are many asthmatics who are not protected from the effects of sulfur dioxide.

The readily observed effects of SO_2 in causing asthma attacks may merely be a miner's canary which warns of even more serious health effects that are not so readily observed. The likely greater effects of SO_2 in persons who have severe asthma are also of concern.

It now seems clear that low concentrations of ambient SO_2 can cause significant asthma attacks. It is increasingly clear that the present air quality standards do not protect all asthmatics. I encourage you in writing a new Clean Air Act to protect all asthmatics with a margin of safety from the adverse health effects of ambient SO_2.

[The prepared statement of Dr. Bethel follows:]

Testimony to the Subcommittee on Mineral Resources Development and Production of the Senate Energy and Natural Resources Committee,

Albuquerque, New Mexico

May 25, 1989

My name is Robert Bethel. I am a medical doctor and specialist in lung diseases at the National Jewish Center for Immunology and Respiratory Medicine and the University of Colorado in Denver. I see many patients who have asthma. In the past, with Drs. Dean Sheppard and Homer Boushey at the University of California, San Francisco, I conducted controlled trials on the effects of sulfur dioxide on asthmatics. Today, I would like to speak on the health effects of sulfur dioxide on asthmatics and try to convince you that current air quality standards do not adequately protect asthmatics.

Sulfur dioxide (SO_2) is released into the atmosphere by coal burning power plants, smelters, pulp and paper mills, and coke plants. SO_2, in low concentrations, causes asthma attacks. Concentrations between 0.25 and 0.50 ppm regularly induce chest tightness in mild asthmatics who are exercising. The asthma attacks induced by sulfur dioxide are typical of other asthma attacks I see in my practice. Patients develop shortness of breath, chest tightness, and wheezing. Sometimes chest tightness induced by SO_2 is severe enough to require medication. The increases in measured airway resistance are significant. We found that mild asthmatics, breathing 0.5 ppm sulfur dioxide for 5 minutes, during moderately heavy exercise, increase airway resistance an average of 238%. Maximal increase was 656%. Exercise increases an asthmatic's sensitivity to SO_2 by increasing the quantity of SO_2 inhaled. Cold dry air, which is common in mountain states in the winter, also increases an asthmatic's sensitivity to SO_2. SO_2 may interact with additional inhaled irritants. Although the mild asthmatics in the exposure studies had significant responses to SO_2, it is likely that persons who have more severe asthma have even greater responses to SO_2. Persons with more severe asthma, in general, have greater bronchoconstrictor responses to inhaled irritants. Thus, low concentrations of ambient SO_2 pose a significant risk to asthmatics.

Current air quality standards do not adequately protect asthmatics from the effects of SO_2. The current primary standards require that average SO_2 concentration not exceed 0.14 ppm over a 24 hour period on more than one day a year. Currently, there is no primary short term standard to protect the health of asthmatics. The consequences of the lack of a short term standard are that ambient SO_2 concentrations are allowed to rise much higher than the standard during parts of the day, so long as average concentration for 24 hours is less than 0.14 ppm. In fact, several SO_2-emitting facilities that meet current standards for SO_2 have been shown to cause transient SO_2 concentrations high enough to induce significant asthma attacks.

Last year the Environmental Protection Agency recommended that the current standards for SO_2 not be changed. In reaching this decision, I think they accepted the premise that not all asthmatics need be protected from the harmful effects of sulfur dioxide. They also suggested that medications and inactivity would prevent many asthma attacks in asthmatics exposed to toxic concentrations of SO_2.

I question whether the Environmental Protection Agency, in making this decision, correctly interpreted the will of Congress to protect the population. As a physician, I think that all persons have the right to breathe air that is not harmful to them even if the reaction caused is transient and reversible. In regard to the use of prophylactic medications to prevent sulfur dioxide-induced asthma, the use of medications is not likely to be entirely effective. Moreover, asthmatics should not have to use medications or tolerate their adverse effects to safely breathe ambient air. Similarly, inactivity is unlikely to prevent SO_2-induced asthma, simply because persons will not remain inactive. Many asthmatics are children and children will not remain inactive. Many adults will maintain activity regardless of the consequences. For other health reasons, asthmatics should not have to lead a sedentary life. Thus, there are many asthmatics who are not protected from the effects of sulfur dioxide.

The readily observed effects of SO_2 in causing asthma attacks may merely be a miner's canary which warns of even more serious health effects that are not so readily observed. The likely greater effects of SO_2 in persons who have severe asthma are also of concern.

It now seems clear that low concentrations of ambient SO_2 can cause significant asthma attacks. It is increasingly clear that the present air quality standards do not protect all asthmatics. I encourage you in writing a new Clean Air Act to protect all asthmatics, with a margin of safety, from the adverse health effects of ambient sulfur dioxide.

Robert A. Bethel

Robert A. Bethel, M.D.

Senator BINGAMAN. Thank you very much.

Our final witness on this panel is James S. Cannon, who is an energy consultant presently with New Mexico Energy, Minerals and Natural Resources Department. Mr. Cannon is also the author of a publication which he has made available to us called the Health Costs of Air Pollution published by the American Lung Association. We are very pleased to have you here, Jim.

STATEMENT OF JAMES S. CANNON, ENERGY CONSULTANT, NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

Mr. CANNON. Thank you, Senator Bingaman. Thank you, Senator Domenici for letting me appear here today.

I am very flattered that you asked me to make a recitation today, and I am proud to participate in this wonderful event, the Clean Air Summit in Albuquerque.

As you mentioned my name is James Cannon. I work in Santa Fe, New Mexico for the Energy, Minerals and Natural Resources Department. Several years ago I researched and wrote a publication for the American Lung Association that analyzed the complex issue of economic costs of health-related effects of air pollution.

Air pollution can sicken and kill human beings. Air quality in Albuquerque, as in about 80 other cities throughout the country, currently violates the carbon monoxide standards set for public health. Public health standards for other pollutants are also being violated in about 100 urban areas. Energy use, primarily fuel burning in cars, buses, and trucks, lies at the core of the air pollution problem in Albuquerque and elsewhere. For example, vehicle pollution, accounts for between 73 and 90 percent of the carbon monoxide pollution in the City of Albuquerque.

Reducing this pollution will cost money, and perhaps a lot of it. But living in a polluted environment also costs money. Health cost information offers insight into the economic benefits to be derived from the pollution abatement programs.

Unfortunately, however, the science of estimating the health costs from air-pollution is in its infancy. The American Lung Association has identified only about 20 comprehensive health cost assessments published in the last decade. Nonetheless, studies today contribute valuable information, and they support a number of observations and conclusions. And I would like to share four of those with you this morning.

First, scientific evidence that air pollution causes discomfort, sickness, and premature death is firmly established. Estimates as high as 140,000 annual premature deaths have been attributed to excessive air pollution in the United States.

Second, there is considerable disagreement as to which pollutants in what concentrations are the principal culprits in causing adverse air pollution effects on health. Studies have found a strong correlation between premature deaths and exposure to particulate, sulfur dioxide, and sulfate pollution. Vehicle pollution, on the other hand, appears to be less life threatening, although it causes pronounced and obvious adverse effects on health and welfare, including aggravation of respiratory ailments, eye and skin irritation, and shortness of breath.

Three, exposure to the air pollutants currently regulated under the national Clean Air Act most likely results in billions of dollars per year in national health costs. The eight studies reviewed in the Lung Association Report indicate that the annual bill for excessive air pollution in the United States is between $5 and $40 million. More recent studies present an even broader range, from $1 billion up to $80 billion per year.

Four, the general range of projected economic benefits from reducing pollution is similar to the estimated costs of several pollution abatement programs, including acid rain and urban ozone control efforts, contemplated as part of the reauthorization of the national Clean Air Act. Reductions in health costs, therefore, could significantly improve the overall economic benefits of reducing pollution.

This adds a new element to the debate if we can afford to reduce pollution. That element is, can we afford not to reduce pollution?

In my testimony I discuss some of the methods that are undertaken to perform comprehensive health cost assessments, and I refer you to the testimony and the book where that subject is discussed in greater detail.

There are many drawbacks to using health cost information, but other than that, we believe that health cost studies have fostered informed decisionmaking in a wide assortment of environmental decisionmaking arenas, and that their use should be encouraged as we face tough environmental policy debates ahead.

New Mexico is fortunate that air pollution problems are largely confined to a few urban areas, but public health threat posed by air pollution here in New Mexico demands a remedy. During the past year the Energy, Minerals and Natural Resources Department has participated in a number of projects designed to promote the use of locally produced natural gas as a clean-burning transportation fuel. Alternative fuels are good environmental policy for the West. They are good economic development policy for the West, and a good national energy conservation policy.

Environmental analyses indicate that natural gas use in vehicles offers an outstanding potential to reduce air pollution, compared to continued use of gasoline or diesel fuel. I might also add that other alternative application of fuels, including methanol and ethanol, also have distinct environmental advantages compared to continued use of fossil-based fuels. New Mexico is the home of one of the largest ethanol industries in the Western United States.

We have a number of projects under way at the state level, with the City of Albuquerque and with the Gas Company of New Mexico. One project in particular involves putting natural gas burning buses on the streets of New Mexico. We are looking to the Mass Transit Administration for help in that project.

New Mexico is one of many states to investigate the use of natural gas. We believe that Albuquerque is an ideal testing ground for alternative transportation fuels because of our high altitude and four-season climate which provides tough standards of testing vehicle operation. Results from demonstration programs here are likely to be very valuable in projecting the benefits of alternative fuel use nationwide.

Currently alternative transportation fuel use is in its infancy and involves applications of infinitesimal amounts in the transportation fuel use. Vastly increased federal participation in research, development, and demonstration of alternative fuel technology is needed if we are ever to gain more than a toehold into the gargantuan automotive industry.

In this regard, in conclusion, I would like to make a few recommendations on the alternative fuel strategy. First, we encourage full funding of the Alternative Motor Fuels Act of 1988. This could open the door to significant Federal involvement in alternative transportation fuel technology.

Secondly, I advocate a major expansion of Federal alternative transportation fuels programs, particular those within the Department of Transportation and the Environmental Protecton Agency. The Alternative Transportation Fuels Act of 1988 opens the door to involvment of the Federal Government,--but it only nibbles the bullet in terms of confronting our major transportation air pollution problems. I am very encouraged that the Clean Air Act enter the debate of the 101st Congress.

Finally, we believe the Federal effort should include Federal participation, financially and technically, in field demonstration programs directed by the State and local governments. It is at the State and local level where most of the innovative work in regard to transportation fuels has occurred to date. The public is demanding increased action to protect public health at the local level. We need your help to accomplish that job.

Thank you very much for your attention.

[The prepared statement of Mr. Cannon follows:]

State of New Mexico
ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT
Santa Fe, New Mexico 87503

GARREY CARRUTHERS
GOVERNOR

TOM BAHR
CABINET SECRETARY
ANITA LOCKWOOD
DEPUTY SECRETARY

TESTIMONY OF JAMES S. CANNON
NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
REGARDING THE HEALTH COSTS OF AIR POLLUTION
BEFORE THE SUBCOMMITTEE ON MINERAL RESOURCE DEVELOPMENT
U.S. SENATE ENERGY AND NATURAL RESOURCES COMMITTEE
ALBUQUERQUE, NEW MEXICO
MAY 25, 1989

Good morning. My name is James Cannon. I am an Energy Consultant to the New Mexico Energy, Minerals and Natural Resources Department. I am also the author of a 1985 study written on behalf of the American Lung Association and entitled The Health Costs of Air Pollution. That book investigated the complex issue of assigning economic costs to the health-related effects of exposure to air pollution.

Thank you for providing me this opportunity to examine briefly the health costs of air pollution and to discuss a program underway at the Energy, Minerals and Natural Resources Department to promote the use of clean-burning natural gas to reduce air pollution.

Air pollution can sicken and kill human beings. Air quality in Albuquerque, as in about 80 other cities throughout the country, currently violates the national public health standard for carbon monoxide. Public

VILLAGRA BUILDING - 408 Galisteo
Office of the Secretary
827 7836
Forestry Division
P.O. Box 2167 827 5830
Park and Recreation Division
P.O. Box 1147 827 7465

MARQUEZ BUILDING - 525 Camino de los Marquez
Office of the Deputy Secretary
827 5950
Administrative Services
827 5925
Energy Conservation & Management
827 5900
Mining and Minerals
827 5970

LAND OFFICE BUILDING - 310 Old Santa Fe Trail
Oil Conservation Division
P.O. Box 2088 827 5800

CAMPUS STATION - Socorro, New Mexico 87801
State Mine Inspector
c/o New Mexico Tech 835 5460

health standards for other pollutants are also being violated in about 100 urban areas. Energy use - primarily fuel burning in cars, buses, and trucks - lies at the core of the air pollution problem in most cities, including Albuquerque. Vehicle pollution, for example, accounts for between 73% and 90% of the carbon monoxide in Albuquerque's air.

Reducing this pollution will cost money, perhaps a lot of it. But living in a polluted environment also carries a price tag. Health cost information offers insight into the economic benefits to be derived from pollution abatement programs. This knowledge can help decisionmakers choose strategies capable of achieving public health protection goals quickly and cheaply.

HEALTH COST STUDIES

The science of estimating the health costs from air pollution is in its infancy. The American Lung Association has identified only about 20 comprehensive health cost assessments published in the past decade; eight were reviewed in the Health Costs of Air Pollution and several more will be examined in an update currently being researched by the Association. The results of studies to date support a number of observations and conclusions, including the following:

o Scientific evidence that air pollution causes discomfort, sickness, and premature deaths in some individuals is firmly established. Estimates as high as 140,000 premature deaths per year have been attributed to excessive air pollution in the United States.

o There is considerable disagreement as to which pollutants in what concentrations are the principal culprits in causing adverse health effects. Studies have found a strong correlation between premature deaths and exposure to particulate, sulfur dioxide, and sulfate pollution. Vehicle pollution, the principal source of carbon monoxide and ozone pollution, appears to be less life threatening, although it causes pronounced and obvious adverse effects on health and welfare including aggravation of respiratory ailments, eye and skin irritation, and shortness of breath.

o Exposure to the air pollutants currently regulated under the national Clean Air Act most likely results in billions of dollars per year in national health costs. The eight studies reviewed in the Health Costs of Air Pollution indicated that the annual bill for excessive air pollution in the United States is between $5 billion and $40 billion. More recent studies present an even broader range, from $1 billion to over $80 billion per year.

o The general range of projected economic benefits from reducing pollution is similar to the estimated costs of several pollution abatement programs, including acid rain and urban ozone control efforts, contemplated as part of the reauthorization of the national Clean Air Act. Reductions in health costs, therefore, could significantly improve the overall economics of reducing pollution.

All health cost studies involve four steps. The first two entail accurately measuring pollution levels and determining the size and composition of the population exposed to the pollution. The third step involves establishing a dose-response function that defines the expected degree of adverse health impact which is likely to result from exposure to a given level of air pollution. In the fourth step, a monetary value is placed on each health response to air pollution, including death, and an expected economic cost is calculated per increment of human exposure to pollution.

Assigning economic worth to sickness and especially to death requires very complex and ethically troubling assumptions, yet overriding public interest in the economics of pollution and pollution control demands that scientists make strides even in this most subjective area of analysis. Most early health cost studies used what is often called the human-capital approach to valuing human health and life. This methodology equates human value to the contribution to society each person offers in terms of wage-earning capability. It links human economic value to the wages lost to a worker through sickness or premature death. Studies based on the human capital approach generally assign a value to human life of less than $1 million.

Most recent health cost assessments have employed a newer concept, generally called "willingness-to-pay," which attempts to measure human economic value according to how much money people actually pay or purport to be willing to pay to enjoy a reduction in risk that they will die prematurely or contract an illness. Some of the techniques used to quantify willingness to pay are salary premiums paid to workers in high risk jobs, public investments in emergency medical facilities which improve health care, and real estate values among neighborhoods similar except in regard to pollution levels. Willingness to pay analyses generally assign a value to human life between $1 million and $7 million.

The methodology for performing health cost studies is gradually being improved, but even the most recent and comprehensive assessments are not able to pinpoint with precision specific health effects associated with human exposure to pollution or the exact economic costs of that exposure. Health cost studies, however, have fostered informed decisionmaking in a wide assortment of environmental decisionmaking arenas. As long as their limited accuracy is acknowledged and their ethical implications and shortcomings are respected, the use of health cost information by decisionmakers facing the tough environmental policy debates that lie ahead should be encouraged.

THE NEW MEXICO NATURAL GAS VEHICLE PROGRAM

New Mexico is fortunate that air pollution problems are largely confined to a few urban areas, but the public health threat posed by air pollution demands a remedy. During the past year the Energy, Minerals and Natural Resources Department has participated in a number of projects designed to promote the use of locally produced natural gas as a clean-burning transportation fuel. These programs, we believe, could help Albuquerque comply with the national public health standards for air pollution while reducing health costs now resulting from human exposure to pollution.

New Mexico has long been one of the nation's largest producers of natural gas, although historically very little of this fuel has been marketed to the transportation sector. New Mexico ranks fourth in the nation in terms of natural gas production and reserves; the proven gas reserve base is estimated at 15.1 trillion cubic feet.

Environmental analyses indicate that natural gas use in vehicles offers an outstanding potential to reduce air pollution, compared to continued use of gasoline or diesel fuel. Reductions in carbon monoxide emissions up to 95% below discharges from conventional vehicles have been demonstrated in natural gas vehicle fleets. Emissions of smog-creating hydrocarbon pollution are also lower in tailpipe discharges from natural gas vehicles. Natural gas use in buses can virtually eliminate discharges of noxious soot and smoke, thereby enhancing the public image of mass transit and the value of mass transit in reducing pollution. With a selling price about 40% cheaper than gasoline, natural gas can offer a cost competitive and cleaner alternative to continued use of gasoline.

Natural gas use as a motor vehicle fuel in New Mexico includes commercial use in a portion of the fleet operated by the Gas Company of New Mexico (Gasco) and in several demonstration projects in Albuquerque. About

100 vehicles have been converted by Gasco to run on natural gas and three refueling stations have been built within its service area. The General Services Department of the City of Albuquerque is currently in the midst of a two-year project which entails the conversion of five city fleet vehicles to run on natural gas. Gasco and the Energy, Minerals and Natural Resources Department are currently members of the Natural Gas Vehicle Coalition.

A final natural gas vehicle project is being developed by Suntrans, the Albuquerque municipal bus company, in cooperation with Gasco and the Energy, Minerals and Natural Resources Department. The project envisions placing ten full-size natural gas buses and six mini-buses into routine revenue service in 1990. Suntrans is seeking partial funding for this project from the federal Urban Mass Transit Administration and from the New Mexico State Oil Overcharge Program.

New Mexico is one of many states to investigate the use of natural gas in the transportation sector. The driving forces behind this effort are the desires to reduce air pollution and to promote national energy security and economic development through the increased use of domestic energy resources. We believe that Albuquerque is an ideal testing ground for alternative transportation fuels because its high altitude and four season climate provide tough environmental conditions for vehicle operation. Results obtained from demonstration programs in Albuquerque are likely to be valuable in projecting the potential benefits of alternative fuel use nationwide.

Currently use of natural gas in transportation applications in the United States is infinitesimal, comprising far less than 1% of the transportation fuel market. Vastly increased federal participation in research, development, and demonstration of natural gas vehicle technology is needed if alternative fuels are ever to gain more than a toehold in the gargantuan automotive industry.

In this regard we encourage Congress to provide full funding to the Department of Energy to implement the Alternative Motor Fuels Act of 1988. Moreover, we advocate a major expansion of federal alternative transportation fuels programs, particularly those within the Department of Transportation (for example, the UMTA's Alternative Fuels Initiative) and the Environmental Protection Agency. These efforts should, we believe, include increased federal financial and technical participation in field testing programs directed by state and local governments.

Thank you for your attention.

Senator **Bingaman**. Thank you very much.

Dr. Spengler, let me ask you first. From your testimony I get the impression that we may be working on the less significant part of the problem as it affects health. At least traditionally the Clean Air Act has focused on pollution, outdoor pollution. I understood you to say that most of the pollution that people are exposed to really occurs indoors, and that the Clean Air Act really has not done anything, EPA has not done anything, to even try to measure or calculate the extent of that.

Did I misread your statements?

Dr. **Spengler**. In part that is correct. In my written testimony, if I may go back to highlight, it is not an indoor-outdoor issue. It is a human exposure issue. There are certain contaminants—ozone and sulfur dioxide, most of the acids—they are primarily outdoor pollutants. Human beings are spending minutes to hours outdoors on a daily basis. That is where they get exposed. This SO_2 short-term effect that my associate panel member spoke about. This is going to be due to outdoor exposure times. If you have combustion indoors, if you have air penetration inside and go through other reactions, a substantial portion of other pollutant exposures are going to be dominated by the indoor exposure; benzene, carbon dioxide, carbon monoxide. Even though we might have a few areas around the country that are in violation, we have unvented combustion going on indoors, underground garages, hotel lobbies, leading to high carbon monoxide exposures indoors that are not even assessed or accounted for in any standard that we have currently set.

The EPA has done some modest work on the level of a few million dollars a year primarily on research, and they have not integrated the issues of human exposures into a well-advised regulatory strategy to improve the public health.

Senator **Bingaman**. Let me ask Dr. Fouts if your group has studied the indoor pollution issue, at all? Is that something that has been funded, research in that area; and, if so, to what extent do you think additional research in that area is something we need mandate as far as the Clean Air reauthorization?

Dr. **Fouts**. I think everything that John said in support of his work and several of our other centers are doing the same kinds of things. Involved are chemicals that are used in many things like rugs and draperies, furniture, upholstery and cleaning fluid, all of these contribute. We are the ones that are doing the tests in the national toxicology program of this these things. I think that those all have to be integrated into the total. As John says, the total exposure of any human being indoor air adds to outdoor air, and the effects on the lungs are the combinations of those additions.

Yes, we do research. We encourage EPA to help us in looking at these things. We try to see what any other agency and any other group is doing on this internationally. We have some studies going on in China. We have some studies going on in Japan. We have some studies going on in Europe. All of which are directed to better understand the role of indoor pollution.

Senator **Bingaman**. I guess I am somewhat struck by the rudimentary level of our understanding after such a long period of time. This thing was authorized first in 1970, and we are still sitting around trying to really get some senses on these very basic decisions about what helps; and what does not help; what the major problems are.

Dr. Spengler, in your testimony you indicate that the EPA's process today for evaluating these health effects is exceedingly long, and we need to speed that up. Maybe you could elaborate on that just a little as to what we can do in the Clean Air Act to speed that up.

Dr. SPENGLER. I can give you some examples. Recently, within the last year or so, after probably a 5-year process or longer, EPA has recommended or they have actually promulgated a new standard of particles. Up until that time we had a national ambient air quality standard with particles that included all sizes of particles that were in the air with no reference to size that may be inhaled; no reference to toxicity in terms of their components; whether they are organic, made out of metals, made out of acids. Actually it took about 18 years to get to putting a size cut into that standard, and the process of even getting that information reviewed was like a 5-year effort.

Now, a size specific standard has been promulgated, cutting particles at 10 microns or smaller, because logically they are the sizes that are going to be inhaled, deposited in the nasal passages, penetrate into the respiratory system.

The worst thing is that the evidence is far beyond that. The evidence on fibers, the evidence on metals, the evidence on the organic compounds and on the acid species would indicate that we have to stop thinking of particles as if they are all of the same thing. It is as ludicrous as if we had set a national standard for gases. Let us have a standard on different gases. All the gases in the air, we will put a standard. It does not make sense. All particles are not same. Earth crustal particles are not the same as emissions from tailpipes. We ought to be more specific as to the toxicity of these materials, because that will tell us what to do in terms of effective control strategy regulations.

EPA has the advantage of a science advisory board, which has been telling them these things for some time now. But the mechanisms by which they must go through a very lengthy process of writing these documents and opening it up to review and—which, of course, it should be, but the length of these is 5 to 10 years to even incorporate the evidence we have now.

Besides the advisory board recommended that the Environmental Protection Agency review the evidence for our acid particles, and within a year set a standard. That is not going to happen. No way.

Senator BINGAMAN. Thank you very much.

Pete.

Senator DOMENICI. Let me stay with you, Doctor. I am looking at your chart 5.

Dr. SPENGLER. Yes.

Senator DOMENICI. I need a little bit of explanation. On the lower right-hand side you are talking about indoor. I understand cigarettes. I understand industry. I understand autos. What does "home" mean and what does "personal" mean?

Dr. SPENGLER. This is data, and actually the evidence that would allow this image of what personal exposures to benzene is more developed than most other organic acids. The way this has evolved is that there are still a myriad of sources, consumer products that out gas benzene that we might have in our own homes.

We have, in fact, a research product under way that utilizes the NASA data that measures the emissions from about 3,000 products and materials that were used in the sky lab space shuttle program. They tell us what organics are coming out of these materials. In fact, there are about 230 commercially available products that still out gas benzene. They are in our homes and part of the source. Also, parking your car in your attached garage allows the evaporation of benzene from your automobile, from your power mower, from other things, and those emissions go into the house.

Senator DOMENICI. Is that auto or is that home?

Dr. SPENGLER. They are from autos directly. This auto directly is from the outdoor air that penetrates inside.

Senator DOMENICI. What is the "personal"?

Dr. SPENGLER. The measurements kept coming back where people actually carried monitors around with them that personal exposures were higher than the outdoors and higher than their homes. So what is it that the person did that was not being reflected in those measurements?

It turns out that when they did the statistical analysis, those that visited a gas station that day, filled up their gas tank that day, got another burst of benzene that shows up as part of their personal exposure.

Senator DOMENICI. In your testimony you made it very clear that you are concerned that we have been talking about ambient exterior, and that we ought to be looking at indoor, in-house. Aside from the pollutants themselves indoors, is it possible that we should be looking at simple things like minimal standards for moving air out of the house, filtration process; cleaning up the air in that house?

Dr. SPENGLER. There are many possibile strategies that have to be explored. Some might be directed to sources. We might do a better job of doing inventories of what out gases and various sources, and make sure that the tetrachloroethylene, the chloroform, is not out gassing from these kinds of products that are used rather ubitquitously in society.

The other solution may be as the Nation's air improves outdoors, it may be just what you suggest; maybe it is setting standards and codes through our building ventilation codes, improve the filtration and improve the ventilation.

Senator DOMENICI. The only reason I brought up the latter is that it appears to me that the former is going to take forever, and maybe the latter could be approached in a reasonable way with standards of ventilation. I do not know enough to understand whether that be would be reasonable. That is why I just asked.

Dr. SPENGLER. Look at this building as an example. Look at the ceiling. You might have great ventilation, but if you have not cleaned up the sources inside, you might do yourself no good at all.

Senator DOMENICI. I understand.

Let me ask just one other question. Somebody mentioned we spent $500 million, half a billion, on acid rain research. You mentioned, Doctor, that you have a very different concern from the primary thrust of acid rain research, which was its effect on the ecosystem. Your concern was its effect on us.

Did we learn very much with the $500 million spent in that project that might have an impact on us for a better understanding the human effect?

Dr. Spengler. I think so. Dr. Fouts talked about the solubilization of metals. This is another route of possible impacts to our aquifer or water system through the solubilization of toxic and heavy metals. Also the deposition on soils and on snowpack is important as proof over the last 10 years. The models look at the emissions, emission sources, their transformation. This is very important information because just to control SO_2 emissions may not solve the problem. We might be revisiting this issue 5 years from now saying, "Gee, you know, maybe it was the nitramine nitric acid that is the thing of issue." In chemistry these are competitive processes. If you reduce one species the other one will dominate.

There has been tremendous advantage, but the point I wanted to make is that now after 10 years that we suddenly recognize that you breathe the acids, not just have them rain on us.

Senator Domenici. Thank you.

Senator Bingaman. Thank you all very much. I think this was very good testimony.

We will take a 10-minute break and then start up again. We have two additional panels.

[Whereupon at 10:20 a.m., a recess was taken.]

Senator Bingaman. Why don't we get started again. The third panel is David Lindahl, Phil Lorang, William Holmberg, and Richard Klimsch.

Let us start with David Lindahl, who is the director of the Office of Alcohol Fuels, U.S. Department of Energy in Washington, D.C. Mr. Lindahl, we are very pleased to have you here and look forward to your testimony.

STATEMENT OF DAVID M. LINDAHL, DIRECTOR, OFFICE OF ALCOHOL FUELS, DEPARTMENT OF ENERGY

Mr. Lindahl. Thank you, Senator. What I am happy to have the opportunity to appear here today before the senate subcommittee to discuss the Department of Energy's efforts concerning alternative fuels.

Can you hear all right?

The Department of Energy's continuing interest in alternative fuels has been since 1978, when it began looking into providing feasibility grants to encourage construction of ethanol plants.

In 1980 the Energy Security Act acknowledged the growing importance of alcohol fuels in its energy outlook and created the Office of Alcohol Fuels. It has provided loan guarantees and grants as available for ethanol plants to be built. These projects, along with others built without federal assistance, accounted for over 850 million gallons of ethanol production last year. Blended with gasoline these oxygenated fuels provided more than 8 percent of the motor fuel sold in the United States last year, almost 9 billion gallons.

Promising technologies or being developed in DOE in industry and at universities that may result in a substantial reduction of production costs within the next decade. DOE's cost goal for ethanol is 60 cents per gallon. Currently it is closer to a dollar at this point. The use of biogenetically engineered bacteria enzymes combined with new production techniques, strongly indicate the program goal is achievable.

DOE has an active alcohol fuels R&D program. For example, in Conservation and Renewable Energy, through 1989, DOE will have invested $83.5 million in biomass-based ethanol R&D and $10.5 million in methanol R&D. The figures in fiscal year 1989 are $2.4 million and $.5 million respectively. Together these amounts constitute about 22 percent of the biomass R&D budget. In addition, a comparable amount is spent on energy crop research.

Only a decade ago there were no systems to convert the cellulose and hemicellulose sugars in wood and grass to ethanol. Today DOE researchers have methods to produce enzymes that will convert these sugars to a fermentable sugar. During fiscal year 1988 researchers increased production of enzymes by genetically altered organisms and developed a reactor system that offers the potential for reducing ethanol costs by 40 percent.

There are many sources of natural gas in the United States that can be used for methanol, because there are fields too remote, in water too deep, and fields too small to be served by pipelines. The technology exists to convert these resources to methanol, which can then be transported into markets by tank trucks or ships.

DOE has been studying methanol as a fuel for several years. The Office of Transportation has conducted research and demonstration programs on neat methanol vehicles in conjunction with several of the national labs. Work is continuing at Los Alamos and Argonne to develop a methanol fuel cell vehicle. DOE recently cosponsored the Methanol Marathon with several other organizations to demonstrate the potential of methanol as a fuel.

The Office of Policy, Planning and Analysis has been studying the issue of methanol supply sources and price as part of the ongoing DOE assessment of alternative fuel costs and benefits. The preliminary analysis indicates that a large scale plant using advanced technology with natural gas feedstock could produce fuel grade methanol at prices ranging from 28 to 37 cents per gallon at the plant gate.

Senator Domenici. At what price do you figure natural gas in that last model?

Mr. Lindahl. Obviously, this would depend to some extent on natural gas prices. I am not certain exactly what price they were using. Obviously it would vary anywhere from——

Senator Domenici. All I am asking is you do not have it in there at cheaper than market, 28 cents?

Mr. Lindahl. I think they were assuming the prevailing market prices. This over a range scenario. That is why they ended up with a range of methanol prices. In fact, I probably should add, this is part of the problem in trying to condense testimony into the limited time available. But these estimates were based on a range of different potential production sites, capital recovery factors, plausible natural gas prices, and that report should be coming out relatively soon. That will, as I say, indicate the natural gas prices that are used to arrive at those particular methanol prices; but it would be at prevailing market rates. It is just the assumption what those prices would be and varied to some extent based on market factors.

In addition, to reach full potential of biomass as an energy resource requires further development of wood and herbaceous energy crops. Our research goal for methanol from biomass is 55 cents a gallon, although current costs are higher than that.

DOE has provided grants for several companies to further their research efforts to convert high-sulfur coal to methanol. The low cost and unsuitability of this coal for many conventional uses make it an attractive feedstock for methanol production. These processes, if successful, could produce electricity, elemental sulfur, slag and methanol. It is too early to determine accurately the production cost of this process, but process development units are being built and more precise data should be available in the near future. The DOE sponsored coal-to-methanol project in LaPorte, Texas, is also showing very positive cost reductions.

Much of the interest in alcohol fuels is a result of the contribution that they can make to the attainment of clean air goals. EPA has reported that the use of oxygenated fuels can be a quick and effectual way to reduce carbon monoxide pollution. Such a fuel change can be made more quickly than automotive hardware changes, which require a turnover of the fleet and may take more than a decade to accomplish. Denver achieved an estimated 12-percent reduction in carbon monoxide with a clean fuel standard and estimates for Albuquerque were slightly higher. Higher fuel oxygen requirements next winter are expected to result in even greater reductions. These improvements in carbon monoxide pollution have led other western cities, such as Phoenix, Tucson, Reno and Las Vegas, to begin oxygenated fuels programs of their own. The use of neat fuels can also have an important impact on ozone precursors. The use of neat ethanol and high percentage blends in Brazil, for example, has been estimated to result in substantial smog reductions, despite large population increases.

The Alternative Motor Fuels Act signed by President Reagan last fall will be an important step forward for alternative fuels. The Secretary recently named Henson Moore, Deputy Secretary of Energy, to be the chairman of the Interagency Alternative Fuels Commission created pursuant to that statute. By appointing Deputy Secretary Moore to this position, Secretary Watkins intended to convey the importance that the Department of Energy attaches to the work of the commission and the United States Alternative Fuels Council, which will provide advice to the commission. The Interagency Commission will have the responsibility for coordinating the alternative fuels activities of the Federal Government. The most important mission assigned to this commission is to develop and implement a national alternative motor fuels policy. The department is moving ahead rapidly to carry out the intent of Congress expressed in this legislation.

Thank you.

[The prepared statement of Mr. Lindahl follows:]

Statement

of

David M. Lindahl
Director, Office of Alcohol Fuels
U.S. Department of Energy

Before the

Senate Committee on Energy and Natural Resources

Subcommittee on Mineral Resources Development and Production

Albuquerque, New Mexico

May 25, 1989

I am happy to have the opportunity to appear today before this subcommittee to discuss the Department of Energy's efforts concerning alternative fuels.

Alternative fuels can enhance energy security by providing a new source of transportation fuel that enhances both our technical options and our market options in the sometimes volatile world energy markets. They can also help to improve air quality because of their clean-burning characteristics.

The Department has had a continuing interest in alternative fuels since 1978, when it began looking into providing feasibility grants to encourage the construction of ethanol plants. In 1980, the Energy Security Act acknowledged the growing importance of alcohol fuels as an energy option and created the Office of Alcohol Fuels. The Office of Alcohol Fuels provided loan guarantees and grants that have enabled five major ethanol plants to be built. Additional assistance was provided by the Department of Agriculture. These projects, along with others built without Federal assistance, accounted for over 850 million gallons of ethanol production last year. Blended with gasoline, these oxygenated fuels provided more than eight percent of the motor fuels sold in the United States last year, almost nine billion gallons.

Some of these plants have been more successful than others. All of the plants built with DOE guarantees defaulted on their loans. Some did not survive the cost-price squeeze of the past two years when grain prices rose and petroleum prices fell. Other plants were able to restructure their financing after DOE paid off the guarantees, however, and are still operating. From those that did not survive the shake-out, we have, nonetheless, learned some lessons. Some technologies proved to be ineffective but were replaced with others that performed well.

Promising technologies are being developed at DOE, industry, and universities that may result in a substantial reduction of production costs within the next decade. DOE's cost goal for ethanol is 60 cents per gallon. The use of biogenetically engineered bacteria and enzymes, combined with new production techniques such as continuous fermentation, ligno-cellulosic conversion (wood-to-ethanol), and ammonia freeze explosion (AFEX), strongly indicate that the program goal is achievable.

DOE has an active alcohol fuels R&D program. For example, in Conservation and Renewable Energy, through 1989, DOE will have invested $83.5 million in biomass-based ethanol R&D and $10.5 million in methanol R&D. The figures in FY 89 are $2.4 million and $.5 million, respectively. Together these amounts constitute about 22 percent of the biomass R&D budget. In addition, a comparable amount is spent on energy crop research.

Only a decade ago, there were no systems to convert the cellulose and hemicellulose sugars in wood and grass to ethanol. Today, DOE researchers have methods to produce enzymes that will convert these sugars to a fermentable sugar. During FY 1988, researchers increased production of enzymes by genetically altered organisms and developed a reactor system that offers the potential for reducing ethanol costs by 40 percent.

Methanol has been produced commercially as a chemical for decades. It has great promise as a neat fuel (85 percent methanol, 15 percent gasoline), blendstock with gasoline, and as a feedstock for the manufacture of the ether MTBE. Currently domestic methanol is almost entirely produced from natural gas by its conversion to an appropriate mixture of hydrogen and carbon monoxide and then synthesis of methanol. However, other feedstocks such as biomass and coal can be used, although the costs are significantly higher, and are not projected to be competitive with gasoline during the next decade.

The United States is currently a major producer of methanol, as is Canada. Several countries around the world with surplus gas, especially remote gas for which there is a limited local market, such as Chile and Saudi Arabia, have built methanol export facilities. There are also many sources of natural gas in the United States that could be used for methanol because they are in fields too remote, in water too deep, or in fields too small to be served by pipelines. The technology exists to convert these resources to methanol, which can then be transported to markets by tank trucks or ships, although the delivered costs of such methanol is likely to be higher than that of imported methanol.

DOE has been studying methanol as a fuel for several years. The Office of Transportation has conducted research and demonstration programs on neat methanol vehicles in conjunction with several of the national labs. Work is continuing at Los Alamos to develop a methanol fuel cell vehicle. DOE also recently cosponsored the Methanol Marathon with several other organizations to demonstrate the potential of methanol as a fuel.

Until U.S. production capacity is increased, it is very likely that much of the initial methanol which could be used as a neat fuel would be imported. That methanol could probably be produced and delivered for about $.50 per gallon. (It takes almost two gallons of methanol to get the same energy as one gallon of gasoline.) The cost of producing methanol depends on a great many factors, including cost of the feedstock, size of production plant, capital recovery rate, and transportation costs. Feedstock cost is the most uncertain of the factors. The Office of Policy, Planning and Analysis has been studying the issue of methanol supply sources and price as part of the on-going DOE assessment of alternative fuels costs and benefits. The preliminary analysis indicates that a large-scale plant using advanced technology with natural gas feedstock could produce fuel grade methanol at prices ranging from 28 cents to 37 cents per gallon (plant-gate price) over a range of different potential production sites, capital recovery factors, and plausible natural gas prices.

The basic technology for producing methanol from biomass remains the same as with natural gas; however, research on gasification and the adaptation of gas modification and compression equipment must be completed before industry can commercialize biomass as a source of methanol. This research is being pursued in the Department at this time. In addition, to reach the full potential of biomass as an energy resource requires further development of wood and herbaceous energy crops. Our research goal for methanol from biomass is 55 cents a gallon, although current costs are higher than that.

As to the availability of a potential feedstock, the Forest Service recently reported that with improved forest management practices there will be a sustainable 10 quads of wood energy available early in the 21st century. The fast-growing species that the Department is currently developing have the potential to increase that to 30 quads. Thus, if production of ethanol or methanol from wood becomes economically feasible there could be sufficient biomass available to replace our liquid transportation gasoline consumption of about 10.5 quads.

DOE has provided grants to several companies to further their research efforts to convert high-sulfur coal to methanol. The low cost and unsuitability of this coal for many conventional uses make it an attractive feedstock for methanol production, although the sulfur must still be removed. These processes, if successful, could produce electricity, elemental sulfur, slag, and methanol. It is too early to determine accurately the production cost of this process, but process development units are being built and more precise data should be available in the near future. The DOE-sponsored coal-to-methanol project in LaPorte, Texas, is also showing very positive cost reductions.

Much of the interest in alcohol fuels is a result of the contribution that they can make to the attainment of clean air goals. EPA has reported that the use of oxygenated fuels (gasoline blended with ethanol or with the ethers ETBE and MTBE) can be a quick and effectual way to reduce carbon monoxide pollution. Such a fuel change can be made more quickly than automotive hardware changes, which require a turnover of the fleet and may take more than a decade to accomplish. Denver achieved an estimated 12 percent reduction in carbon monoxide with a clean fuel standard and estimates for Albuquerque were slightly higher. Higher fuel oxygen requirements next winter are expected to result in even greater reductions. These improvements in carbon monoxide pollution have led other western cities, such as Phoenix, Tucson, Reno and Las Vegas, to begin oxygenated fuels programs of their own. The use of neat fuels can also have an important impact on ozone precursors. The use of neat ethanol and high percentage blends in Brazil, for example, has been estimated to result in substantial smog reductions, despite large population increases.

The use of neat methanol is projected to grow rapidly in California for similar reasons. For example, faced with severe air quality problems and the prospect of EPA sanctions, Southern California is planning for much greater use of neat methanol. By the end of 1993, according to the Air Quality Management Plan for the South Coast Air Quality Management District, commercial fleets of 15 vehicles or more are to be converted to methanol or electricity, as are a large number of stationary sources. By the year 2004, the plan also estimates that 40 percent of the transportation fuel used there will be methanol.

The use of alternative fuels could also contribute to mitigation of potential global climate change. Unlike fossil fuels, ethanol and methanol made from biomass are CO_2 neutral; the CO_2 that is released from their combustion is recaptured in the growth of the biomass from which they are made. The biomass also fixes some carbon in the soil, providing a partial "carbon sink." Methanol made from natural gas, however, would be a modest CO_2 contributor, and methanol made from coal would be a significant CO_2 contributor.

The use of alternative fuels can also make an important contribution to our energy security, especially if made domestically, either from surplus crops or, in the case of methanol, from gas or coal. The production of these fuels domestically would reduce the amount of crude oil and petroleum products that the country must import. However, the energy security benefits would be diminished if the alternative fuels are imported, as initially is likely for ecomonic reasons.

The Alternative Motor Fuels Act signed by President Reagan last fall will be an important step forward for alternative fuels. The Secretary recently named Henson Moore, Deputy Secretary of Energy, to be the Chairman of the Interagency Alternative Fuels Commission created pursuant to that statute. By appointing Deputy Secretary Moore to this position, Secretary Watkins intended to convey the importance that the Department of Energy attaches to the work of the Commission and the United States Alternative Fuels Council, which will provide advice to the Commission. The Interagency Commission will have the responsibility for coordinating the alternative fuels activities of the Federal Government. The most important mission assigned to this Commission is to develop and implement a national alternative motor fuels policy. The Department is moving ahead rapidly to carry out the intent of Congress expressed in this legislation.

As the public becomes more aware of the potential contribution of alternative fuels and as the cost and efficiency of their production and use improve, interest in them will continue to increase. The Department of Energy will continue to work diligently to explore the promise and potential of alternative fuels.

That concludes my prepared statement. I would be pleased to answer any questions you might have.

Senator BINGAMAN. Thank you very much.

Our second witness on this panel is Phil Lorange, who is the Chief Technical Support Staff, Emission Control Technology Division of the Office of Mobile Sources, Environmental Protection Agency. He is out of Ann Arbor, Michigan. We appreciate very much you being here.

STATEMENT OF PHILIP A. LORANG, CHIEF, TECHNICAL SUPPORT STAFF, EMISSION CONTROL TECHNOLOGY DIVISION, OFFICE OF MOBILE SOURCES, ENVIRONMENTAL PROTECTION AGENCY

Mr. LORANG. Good morning, Mr. Chairman and Senator Domenici. My title is so long because I am, in fact, fairly down the line in the EPA organization. The person who was invited, Dick Wilson, who has a shorter organizational title, was unable to attend today.

EPA has been increasingly active in the area of alternative fuels in a number of important ways, and I want to mention just four of the eight ways that I have listed in the testimony.

First, our enforcement of the Clean Air Act's requirement that states adopt and implement plans to achieve clean air has helped to create interest in alternative fuels that is obvious in the United States, particularly throughout the West. We also must take over the plan process for any state that has not developed its own plan successfully. Alternative fuels are an option that we consider in such a circumstance. Currently we are in a situation now in the area of Chicago and the area of the southern coast in California.

Second, we are very active with the Department of Transportation and Energy to develop field trials and demonstrations of alternative fuel vehicles, especially buses.

Third, EPA, along with the Department of Energy, plays an important role within the administration in formulating policy options for alternative fuels at the Federal level and assessing their domestic and international consequences.

Finally, EPA conducts and requires industry to conduct studies on the health and atmospheric effects of alternative fuels and their combustion products.

Alternative fuels offer the promise of helping to alleviate four air pollution problems: ozone, carbon monoxide, particulate matter, and air-born carcinogenic chemicals.

It is helpful to divide the various alternative fuels that are being considered into two groups. One group includes those fuels that are primarily composed of gasoline and low levels of oxygenated additives.

The second group includes alternative fuels that would be used as replacements for gasoline in new vehicles entering the fleet that are specifically designed to take advantage of the characteristics of these alternative fuels.

The primary benefit of these gasoline blends relates to the oxygen contents in the additives, thus these are all referred to as oxygenated blends. Gasahol has the highest oxygen content of about 3.5 percent. Based on the types of vehicles in the fleet today, EPA believes that the use of gasahol in all vehicles would reduce carbon monoxide emissions by 25 percent. The 3.1 percent program recently endorsed by the Albuquerque city council would reduce emissions slightly less, by 20 or 21 percent.

Turning now to the replacement fuels, methanol, ethanol, compressed natural gas, and propane, all have the potential to significantly reduce the ozone and the carcinogenic contribution of motor vehicles, but not particularly the carbon monoxide contribution.

We project that the emissions from the current technology methanol vehicles, which might be sold in a few years, to meet current EPA standards applicable to methanol vehicles would create 30 to 40 percent less ozone than today's vehicles. It would reduce carcinogenic emissions by about one-third.

It is important to recognize that current engine designs, such as ones that produce ozone, have been optimized for gasoline, and can be modified only slightly to use methanol. We have only recently begun to investigate the potential for engines to take full advantage of methanol's characteristics.

However, a few such engines have been developed by manufacturers and tested by EPA in Ann Arbor. We project that future advanced technology methanol vehicles could reduce the ozone potential and carcinogenic emissions of vehicles by 80 to 90 percent, a startling reduction. It is necessary with advanced methanol vehicles to pay close attention during development to optimal control of formaldehyde emissions, which do tend to be higher with methanol combustion.

To date, few vehicles have been designed to operate on ethanol in the United States. We believe, however, that the use of pure ethanol as a motor vehicle fuel would offer the same type of emissions benefits as methanol. The primary issues associated with ethanol's use as a replacement fuel are available supply and cost.

Most of the vehicles currently operating in the United States on compressed natural gas are gasoline vehicles retrofitted with a conversion kit to allow the vehicle to operate on either CNG or gasoline. This creates compromises in vehicle performance and in emissions. As with methanol, we believe compressed natural gas is best suited for engines designed specifically for its use. Such vehicles would likely achieve a reduction of 50 to 90 percent both ozone-producing potential and carcinogenic emissions.

EPA will continue to study the potential health and environmental impacts associated with alternative fuels, such as impacts on global warming, a new concern. Our studies are aimed at assuring that any adverse impacts are minimized or eliminated.

In summary, we believe alternative fuels can play an important role in improving air quality in certain areas of the country. EPA stands ready to work with any state or local agency that is considering the use of alternative fuels, as we have already done with the five Western states.

Thank you for this opportunity to address these matters. I will be pleased to answer any questions from the panel once the presentations are done.

[The prepared statement of Mr. Lorang follows:]

STATEMENT OF PHILIP A. LORANG
CHIEF OF THE TECHNICAL SUPPORT STAFF
EMISSION CONTROL
TECHNOLOGY DIVISION
OFFICE OF MOBILE SOURCES
OFFICE OF AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON MINERAL DEVELOPMENT AND PRODUCTION
OF THE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

MAY 25, 1989

Good morning, Mr. Chairman and Members of the Subcommittee. I am Philip A. Lorang, of EPA's Office of Mobile Sources. I am pleased to appear before you today to testify on the subject of EPA's activities regarding alternative fuels, both current and future. Let me convey again Mr. Richard D. Wilson's regret at not being able to appear today himself.

EPA has been increasingly active in this area, reflecting the realization that vehicle hardware has been developed to a high degree of refinement and that further large steps towards clean air require more of a fuel orientation.

EPA is active in the area of alternative fuels in a number of important ways:

1. Our enforcement of the Clean Air Act's requirement that states adopt and implement plans to achieve clean air has helped create the state and local interest in alternative fuels that is obvious throughout the U.S.
2. Our estimates of the environmental effects of alternative fuels, based on testing in our own and in other laboratories, gives state and local planners and decision makers the numbers they need to make local decisions on alternative fuels.
3. We are the gatekeeper to the gasoline market, and must review and approve any new additives mixed into unleaded gasoline. Congress gave us this role to be sure that emission controls on vehicles are not damaged by new gasoline formulas.
4. We do research to define the limits of what emissions and fuel efficiency performance can be achieved with alternative fuels in different types of engines.
5. We have worked very actively with the Departments of Transportation and Energy to develop field trials and demonstrations of alternative fuel vehicles and buses.
6. EPA, along with DOE, play an important role within the Administration in formulating policy options for alternative fuels and assessing their domestic and international consequences.

7. EPA is the lead agency for setting air, water, and other environmental standards for the domestic alternative fuel industry.

8. EPA conducts and requires industry to conduct studies on the health and atmosphere effects of alternative fuels and their combustion products.

Alternative fuels offer the promise of helping to alleviate four air pollution problems: ozone, carbon monoxide, particulate matter, and air-borne carcinogenic chemicals.

Ozone remains a serious national problem, with 81 cities in nonattainment based on the preliminary data from last year's extremely hot summer. Ozone is not emitted directly, but is a product of a series of complex atmospheric processes involving hydrocarbons, nitrogen oxides, and sunlight. Motor vehicles are typically responsible for about one-half of ozone precursor emissions. Albuquerque does not presently exceed the ozone standard, but it comes close enough at times to deserve some attention.

Carbon monoxide is also a significant problem. Based on 1987 data, there are 52 areas nationwide that exceed the federal carbon monoxide standard. Motor vehicles are responsible for 80 to 90 or even more percent of carbon monoxide emissions in urban areas, so fleet turnover has been very helpful in lowering ambient levels. We project that about 19 areas will need further controls, in addition to fleet turnover, to reach carbon monoxide attainment if we set 1995 as the new target for this important goal. Albuquerque is one of these areas, which fortunately is taking further steps.

Many areas have a serious particulate matter problem. While vehicles that use unleaded gasoline emit very low levels of particulate matter, diesel-fueled trucks and buses are important sources of inhalable particulate, especially in central city areas. In addition, ozone precursors play a role in secondary particulate.

Finally, all urban areas sit in a soup of self-generated chemicals that add to each person's risk of contracting lung or other types of cancer. Motor vehicles cause about one-half of the risk from this soup through their tailpipe emissions and by evaporation of gasoline. In a city the size of Albuquerque, EPA estimates that two or three extra cancer cases occur each year due to motor vehicle pollution.

It is helpful to divide the various alternative fuels that are being considered into two groups. One group includes those fuels that are primarily composed of gasoline and low levels of additives that can reduce vehicle emissions. One significant advantage of such fuels is that because they are so similar to straight gasoline, current vehicles need no modifications to operate on them. In fact, millions of vehicles spread all over the U.S. are operating on them every day. The corresponding drawback is that because the fuel is still primarily gasoline, it is not possible to take full advantage, in terms of either emissions or efficiency, of all of the potential benefits of the additive. The four gasoline additives generating the most interest are ethanol, methanol, methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE).

The second group includes alternative fuels that would be used as replacement fuels for gasoline. The optimum use of these fuels would be in new vehicles entering the fleet that are specifically designed to take full advantage of the combustion characteristics of these alternative fuels. The primary replacement fuels of interest are methanol, ethanol, compressed natural gas (CNG), and propane. The emissions impacts of gasoline additives are generally quite distinct from those of the replacement fuels. I would like to first briefly discuss gasoline additives, before moving to a more detailed analysis of the replacement fuels.

There are currently six gasoline additive formulations which are approved by EPA. These are: 1) Gasohol, which is 90 percent gasoline and 10 percent ethanol; 2) DuPont, which is 92.5 percent gasoline, 5 percent methanol, and 2.5 percent ethanol or similar alcohols; 3) Octamix, which is 92.5 percent gasoline, 5 percent methanol, and 2.5 percent higher alcohols; 4) Oxinol, which is 90 percent gasoline, 5 percent methanol, and 5 percent tertiary butyl alcohol; and 5) MTBE, which can be legally blended up to 15 percent with gasoline; and 6) ETBE, which can be legally blended up to 13% with gasoline. The DuPont, Octamix, and Oxinol formulas are not presently being sold to any significant extent, having been eclipsed by MTBE. ETBE has not yet been commercialized but may be if it is granted a tax subsidy.

As mentioned above, these gasoline blends generally have combustion characteristics very similar to those of straight gasoline and can be used in existing vehicles. All of the additives -- ethanol, methanol, MTBE, and ETBE -- increase the octane of the gasoline blends, although they also decrease the overall energy content of gasoline somewhat. Energy content and octane do not significantly affect emissions in a direct way, however. The properties of these gasoline additives that do affect emissions are that 1) they all contain oxygen in their chemical structure; 2) the alcohols (ethanol and methanol) raise the vapor pressure, or volatility, of gasoline; and 3) they all allow the gasoline portion of the blend to be reformulated with lower levels of aromatic fuel molecules which leads to reduce emissions of carcinogenic benzene.

The primary emission benefit of these gasoline blends relates to the oxygen content in the additives, thus these blends are often referred to as oxygenated blends. Carbon monoxide emissions are a strong function of the air-fuel ratio of an automotive engine. The net result of having oxygen in the fuel is that a vehicle will operate at a "leaner" air-fuel ratio, producing lower carbon monoxide levels. Gasohol has an oxygen content of about 3.5 percent. Based on the types of vehicles in the fleet today, our analysis indicates that the use of gasohol in all vehicles would reduce motor vehicle emissions of carbon monoxide by 25 percent. The 3.1% oxygen program recently endorsed by the Albuquerque City Council will reduce carbon monoxide emission from vehicles by about 21 percent.

The ongoing oxygenated blends programs in parts of Colorado, Arizona, Nevada, and here in New Mexico will give EPA and state and local agencies an excellent opportunity to evaluate the costs and benefits of such programs.

Turning now to the replacement fuels, methanol, ethanol, compressed natural gas, and propane all have the potential to significantly reduce the ozone and the carcinogenic (e.g., benzene, 1-3 butadiene) contribution of motor vehicles. The ozone benefit is not just because these fuels and the vehicles designed to burn them can reduce the mass of volatile organic emissions compared to those of gasoline vehicles, but also because the hydrocarbon emissions from these fuels have been shown to be less photochemically reactive, in other words, less likely to form ozone, than those of gasoline vehicles. With respect to ozone formation, all hydrocarbon compounds are not created equal. We have known for quite some time that methane emissions, the primary hydrocarbon in CNG vehicle exhaust, are very, very slow to react in the atmosphere. More recently, we have learned that methanol emissions have a low photochemical reactivity, and it is thought that ethanol and propane also have somewhat lower reactivities than average gasoline hydrocarbons. Because the alcohols have low vapor pressures, we also find much lower evaporative hydrocarbon emissions, which lowers the overall ozone contribution even more. CNG fuel systems need to be entirely closed to the atmosphere and, thus, evaporative emissions should be zero.

Methanol is an excellent engine fuel that can be produced from natural gas, coal, oil shale or biomass. When produced from natural gas, it is currently priced at a level fairly close to gasoline on an energy basis. Production from other sources costs considerably more. Current methanol vehicles utilize engines that are very similar to engines used in today's gasoline vehicles, with modifications to allow the engine to operate well, but not optimally, on methanol. These are also the types of engines that will be utilized in methanol flexible fuel vehicles, of course, since such engines need to be able to operate on methanol, gasoline, or any blend of the fuels. Based on the existing methanol vehicle emissions data base, and the results of several smog chamber and computer modeling studies, we project that the emissions from current technology methanol vehicles certified to emission standards equivalent on a carbon basis to those applicable to gasoline vehicles would create 30 to 40 percent less ozone than today's gasoline vehicles. These current methanol vehicles would cut carcinogenic emissions by about one-third. We would not expect significant improvements for any other pollutant from current technology methanol vehicles.

It is important to recognize that current engine designs have been optimized for gasoline, particularly over the last 20 years. We have only recently begun to investigate the potential for engines to take full advantage of methanol's fuel characteristics. Although there is still much to learn, we think it is clear that engines optimized to take advantage of methanol's high octane, high flame speed, and wide flammability limits could be much cleaner and more efficient than current methanol vehicles. Such an engine should include high compression, advanced fuel injection, and an emission control system designed to reduce formaldehyde emissions to the lowest level possible. A few such engines have been tested, and we project that future advanced technology methanol vehicles could reduce the ozone potential and carcinogenic emissions of vehicles by 80 to 90 percent. The carbon monoxide and nitrogen oxide emission impacts would depend on whether the engines are designed for stoichiometric or lean combustion. Lean combustion would reduce carbon monoxide and increase efficiency, but likely with foregone nitrogen oxide reductions. Stoichiometric operation could yield very low nitrogen oxide levels, but would limit improvements in carbon monoxide and efficiency. It is necessary with advanced methanol vehicles to pay attention during development to optimal control of formaldehyde emissions, which tend to be higher with methanol combustion.

To date, few vehicles have been designed in the United States to operate on pure ethanol, although Brazil's transportation system runs predominantly on ethanol. We believe that the use of pure ethanol as a motor vehicle fuel would offer the same type of emissions benefits as methanol, and in fact because the two fuels are so similar an engine designed for methanol would be able to operate well on ethanol with only minor modifications, and vice versa. The reactivity of ethanol vehicle hydrocarbon emissions has been studied less extensively. It appears that ethanol emissions are more reactive than methanol emissions, but still less reactive than average gasoline emissions. The primary issues associated with ethanol's use as a replacement fuel are supply and cost. Currently, ethanol from grain costs more than other octane enhancing gasoline additives and would not be produced in volume without substantial tax incentives.

Most of the vehicles currently operating in the U.S. on CNG fuel are gasoline vehicles retrofitted with a conversion kit to allow the vehicle to operate on either CNG or gasoline. Last year EPA tested three dual fuel CNG vehicles, involving conversions of late model computer-controlled gasoline vehicles. At this time, we estimate that dual fuel CNG vehicles would contribute 50 to 80 percent less to ozone when operated on CNG than gasoline vehicles. If conversions are properly performed and maintained, there are typically large carbon monoxide emissions reductions as well. Drawbacks associated with CNG conversions include generally higher nitrogen oxides emissions and poorer vehicle performance, due to both less engine power and increased weight from the pressurized CNG cylinders. As with methanol, we believe CNG is best suited for engines designed specifically for its use.

Such vehicles would likely achieve a 50 to 90 percent reduction in ozone-producing potential and very low carcinogenic and carbon monoxide emissions.

The use of any of these replacement fuels as pure fuels in large truck and bus engines would essentially eliminate the diesel particulate or smoke that is characteristic of diesel engines. In certain central city areas buses and trucks contribute significantly to high particulate levels. EPA has been very supportive of methanol bus programs ongoing or planned in San Francisco, Riverside, Los Angeles, Jacksonville, Seattle, and Denver, all sponsored by the Urban Mass Transportation Administration (UMTA), and has played a lead role in coordinating a unique methanol bus demonstration program in New York City involving General Motors, the Detroit Diesel Corporation, the Natural Resources Defense Council, the Center for Auto Safety, and Hoechst Celanese. Two CNG buses are now also operating in New York City, which will permit a comparison between methanol and CNG technologies and existing diesel engines.

EPA will continue to study the potential health and environmental impacts associated with alternative fuels, such as impacts on global warming. Our studies are aimed at assuring that any adverse impacts are minimized or eliminated.

In summary, we believe alternative fuels can play an important role in improving air quality in certain areas of the country. EPA stands ready to work with any state or local agency that is considering the use of alternative fuels.

Thank you for this opportunity to address these important matters. I will be pleased to answer any questions that the Subcommittee may have.

Senator BINGAMAN. Thank you very much.

Our next witness is William C. Holmberg, who is an environmental consultant with the Clean Fuels Development Coalition out of Washington, D.C. Mr. Holmberg is a former official with the Department of Energy and EPA.

We are very pleased to have you here.

STATEMENT OF WILLIAM C. HOLMBERG, ENVIRONMENTAL CONSULTANT, CLEAN FUELS DEVELOPMENT COALITION

Mr. HOLMBERG. Thank you very much. Thank you, Mr. Chairman.

The Clean Fuels Development Coalition is a group dedicated to improving transportation fuels——

Senator BINGAMAN. You might pull that microphone up a little closer there, please.

Mr. HOLMBERG [continuing]. Dedicated in improving transportation fuels both in terms of performance in the car and in the environment.

In the past decade the nation has made major progress involving the transportation sector. Engine technology has reduced emissions by 90 percent. The average miles per gallon has advanced by 35 percent. Lead gasoline is practically gone. Alternative fuels now exceed 2 percent of gasoline sales; not much but it is a start.

But there are also red flags of warning. Consumption of gasoline is up by 10 percent since 1980. Transportation now accounts for 62 percent of the petroleum: up from 53 percent three years ago. We have pumped about 32 billion barrels of irreplaceable oil from the bowels of our nation in the past 10 years. We continue to embarrass ourselves by consuming 25 percent of world oil production while holding only 4 percent of the reserves. Imports of oil and petroleum products have returned to 1979 levels. Air quality in key parts of the country have actually worsened. Ozone, acid rain and global warming are all tied to fossil fuel.

In summary, the good news is that the cars have gotten better, getting darn good. The bad news is that the gasolines in terms of quality and secure domestic supplies have gotten worse. Since early 1980 summertime gasoline vapor pressure has been increasing. The levels of aromatic hydrocarbons; benzene, a potent carcinogen; and xylene, a highly photochemically reactive, have been increasing. The general quality of gasoline has not kept up with the advances in engine technology to increase mileage and reduce emissions. And the oil companies have largely neglected human health and the environment in making manufacturing choices.

These choices, and there were better alternatives, driven primarily by bottom line considerations, highlight the critical importance of federal clean fuel standards to include: 3.1 percent weight oxygen content standard for gasoline sold in all carbon monoxide and ozone and non-attainment areas year-round; lowering the summertime vapor pressures; lowering the levels of aromatic hydrocarbons, low-boiling olefins and the iso-parafins; requiring "truth in advertising" to preclude exaggerated performance claims used to market high octain fuels; and encouraging use of domestic renewable and other cleaner burning alternative transportation fuels.

The increased use of the oxygenates, methyl tertiary butyl ether and ethyl tertiary butyl ether, would allow substantial reductions in imported gasoline and crude oil. For example, 90 million barrels a year of retained surplus will drop out of gasoline as a result of voluntary restrictions in the next two to three years.

Isobutylene produced from the surplus butane could be reacted with ethanol to produce 132 million barrels of ETBE to replace about 180 million barrels of crude oil imports annually. At this rate in four years the savings would amount to more oil than is stored in the Strategic Petroleum Reserve; 132 million barrels of ETBE, if blended with gasoline at the 20-percent level, will enhance 27 billion gallons of gasoline by: boosting the octane by four points; reducing vapor pressure to 8.8 pounds and 10 psi gasoline; cutting emissions by 12 to 34 percent; reducing unburned hydrocarbons by 10 to 15 percent, and aromatic hydrocarbons by 68 percent; reducing photochemcial reactivity index by 78 to 83 percent; and reducing carbon dioxide emissions by 7 percent, with the opportunity to increase this by an order of magnitude with proper conversion and farm practices.

It is my belief that these suggestions are not only economically-viable clean air agenda, but also represent a potential to reduce carbon dioxide releases from the transportation sector by 20 percent by the year 2020. Additional information on these issues is included in my testimony.

Thank you for this opportunity.

[The prepared statement of Mr. Holmberg follows:]

Testimony of William C. Holmberg before U.S. Senator Jeff Bingaman, Chairman of the Subcommittee on Mineral Sources, Development and Production of the Committee on Energy and Natural Resources in Albuquerque, New Mexico, Thursday-May 25, 1989.

Thank you Mr. Chairman for this opportunity to present my views to this distinguished audience. My name is Bill Holmberg; I am an environmental consultant to the Clean Fuels Development Coalition, a group of industry, business, and public interests dedicated to improving transportation fuels, both in terms of performance in the car and in the environment. We also work for the advancement of alternative fuels - ethanol, methanol, the ethers (methyl tertiary butyl ether - MTBE and ethyl tertiary butyl ether - ETBE), compressed natural gas, liquified natural gas, propane, electricity, and hydrogen. CFDC also supports increased energy efficiency and an enhanced environment.

In the past decade the nation has made major progress on a variety of fronts involving the transportation sector:

o Automotive emissions have been reduced by 90% as a result of advances in engine technology;

o Improvements have been made in air quality in many parts of the country;

o Average miles per gallon of the U.S. fleet has advanced from 14 to 19 mpg, a 35% increase;

o For all practical purposes, lead has been removed from gasoline; and

o Alterative transportation fuels have established a beachhead in the marketplace-taken together, they now exceed two percent of gasoline sales.

But, the past decade is also serving us with a warning:

o Consumption of gasoline is up about 10% since 1980 in spite of greatly improved mileage;

o The transportation sector now accounts for over 62% of the petroleum used in the United States, up from 53%;

o We have pumped about 32 billion barrels of irreplaceable oil out of American earth in the past decade;

o We still consume about 25% of the world's oil production while holding only about 4% of proven reserves;

o Imports of oil and petroleum products have returned to 1979 levels, a time when our energy and economic security were threatened by this level of dependency;

o Air quality in key parts of the country has actually worsened in terms of ozone and particulary under difficult weather conditions witnessed last summer (in addition, a recent NRDC report indicates that EPA is significantly under-reporting ozone exceedences); and,

o Ozone, acid rain, and global warming resulting from the build up of carbon dioxide and other greenhouse gases are of mounting concern to the world.

In summary, the good news is that the cars have gotten better. The bad news is that gasolines, in terms of quality and secure domestic supplies, have grown worse.

U. S. gasoline composition is at fault for a number of reasons including:

o Since the early 1980s, the summertime gasoline Reid vapor pressure has been increasing;

o The levels of aromatic hydrocarbons (benzene - a potent carcinogen; toluene; and xylene - highly photochemically reactive) have been increasing; and

o The general quality of gasoline has not kept up with the advances in engine technology to increase mileage and reduce emissions.

o The unfortunate position taken by the major gasoline-producing oil companies in not assigning an adequate priority to the protection of human health and the environment when making their fuel manufacturing choices. The unhealthy consequences of these choices were simply forced on an unsuspecting public. These choices (and there were better alternatives for people and the environment), driven primarily by bottom-line considerations, highlight the importance of Federal clean fuel standards.

Fortunately, there are actions underway to bring the quality of transportation fuels up to levels needed to meet environmental and energy security imperatives.

These forces should establish new national transportation fuel standards embracing the following parameters:

- 3.1 % (wt) oxygen content standard for gasoline sold in all carbon monoxide and ozone non-attainment areas year around;
- Lowering the summertime Rvp to the level necessary to meet ozone standards while maintaining engine performance and providing a base gasoline to accommodate the characteristics of the oxygenates;
- Lowering the levels of aromatic hydrocarbons, low-boiling olefins (highly photochemically reactive) and the iso-paraffins (carcinogenic);
- Requiring "truth-in-advertizing" to preclude exaggerated performance claims used to advertise high octane fuels; and
- Encouraging the use of domestic, renewable, and other cleaner burning alternative transportation fuels that will also reduce carbon dioxide loadings in the atmosphere.

The year-round requirement of 3.1 % (wt) oxygen is necessary in order to encourage the capital investment in ethanol, methanol, MTBE, and ETBE facilities.

Oxygenated fuels offer the most cost-effective method of CO and ozone reduction. Ethanol, for example, does have a high blending vapor pressure. However, the reductions in carbon monoxide (an ozone precursor) resulting from its high oxygen content (3.7%) more than offset the increase in evaporative emissions (also ozone precursors). But, ozone reductions would be greater with a lower Rvp blendstock for the ethanol, an option to the refiners.

The octane requirements of about 80% of the cars operating in the United States can be met with 87 octane (R+M/2) gasoline. About 40% of the new cars sold in 1988 have built in knock sensors which can both accommodate lower octane fuels and take advantage of the higher octane gasoline. Further complicating the issue is that the availability of higher octane gasoline permits automakers to boost compression ratios and increase the efficiency of their engines. But, the bottom line is that the purchase of gasoline with an octane higher than the engine's needs causes a double penalty - added cost to the consumer and a worse environmental and human health impact.

The nation needs consumers' understanding of these facts. With enlightened drivers, it is likely that there would be sufficient savings in limiting the purchase of octane to meet the actual needs of the engine (rather than the perceived needs of the driver generated by advertising) to pay for the standards suggested above.

For example, about 25% (27 billion gallons) of the gasoline sold in the U.S. is premium grade costing the consumer about $.10 a gallon more than regular unleaded. Assuming that about half of this is literally a wasted consumer expense, $1.4 billion could be saved annually by satisfying the needs of the engine rather than meeting advertising goals. With the sales of premium increasing at the rate of 2-3% per year a sensible approach to octane will represent significant environmental and financial savings.

The public should also be demanding quality regular-unleaded gasoline with the needed additive package to meet modern engine needs. They should not be forced to buy a high octane fuel to get a high quality gasoline.

To deal with complicated issues like octane, improved and cleaner burning gasolines, and the transition to alternative transportation fuels, it is strongly recommended that the U.S. Department of Energy and the Environmental Protection Agency establish a small working task force made up of representatives of the auto and oil industries as well as representatives from the other fuels (ethanol, methanol, compressed natural gas, liquified natural gas, propane, electricity, and hydrogen) and energy conservation and mass transit proponents.

It is also recommended that special incentives be made available to encourage the conversion of butane into isobutylene, an essential component of MTBE and ETBE production. With reductions in RVP and the increased production of clean burning natural gas, butanes are looking for a new market, but the conversion technology is a major capital investment and will likely need financial incentives from the government.

The conversion of surplus butanes into isobutylene needed for the reaction with ethanol or methanol to produce the ethers (ETBE and MTBE) would allow substantial reductions in imported gasoline and crude oil. For example:

- It is recognized that 90,000,000 bbl/year of butane surplus will result from gasoline volatility restrictions in the next 2-3 years. Another estimated 30 million bbl/year is produced by the gas industry to meet other needs.

- These 90 million barrels of isobutylene (produced from butane) could be reacted with 56 million barrels of ethanol to produce 132 million barrels of ETBE to replace about 180 million barrels of crude oil imports annually. At this rate, in four years the savings would amount to more oil than is stored in the Strategic Petroleum Reserve.

- This 132 million barrels, or 5.5 billion gallons of ETBE, if blended with gasoline at the 20% volume level, will improve and enhance those 27 billion gallons of gasoline by:

    1. Boosting the octane by 4 points;

2. Reducing vapor pressure to 8.8 psi in a 10 psi base gasoline (the blending vapor pressure of ETBE is 4 psi);

3. Cutting CO emissions by 12-34% (depending on the car);

4. Reducing unburned hydrocarbons (UHC) by 10-15%, and aromatic hydrocarbons (benzene, toluene, xylene - BTX) by 68%;

5. Reducing photochemical reactivity index (UHC+BTX) by 78-83% (volatility, CO, UHC and photochemical reactivity index plus NOx [NOx emissions are neutral] are the principal determinants in the formation of ozone) and;

6. Reducing carbon dioxide (CO_2) emissions by 7.3% - this can be increased by a factor of ten through increased efficiency in farming and ethanol production, by following sustainable agricultural practices, and by using renewable energy in the conversion process.

Combining this level of gasoline market penetration with the other oxygenates, with a determination to shift to alternative fuels (ethanol, methanol, CNG, LNG, propane, electricity, and hydrogen) and the increased use of flexible fuel vehicles will put the country squarely and economically on the road to cleaner air, increased energy security, and improved farm economy (attached is a paper supporting an expanded ethanol program because of benefits to the farmer and the taxpayer).

This hearing offers an appreciated opportunity to surface important concepts and questions.

o It is an opportunity to make the point that farmers must be encouraged to work, fertilize, and protect their land in a manner that actually builds healthy top soil (a carbon sink) so as to permit a greatly expanded ethanol program without environmental degradation. The science and the technology are there. Information, technology transfer, and incentives are the missing components.

o Is it in the best interest of the nation and its environment to convert clean burning natural gas, which can be used in a compressed or liquified form for transportation fuels, particularly in fleets, into methanol for use as a neat fuel? This should be considered in light of the energy, economic and environmental penalties resulting from the conversion and the combustion of methanol. Methanol as a blending oxygenate will be in increasing demand as the volume of isobutylene increases as a result of mounting butane surpluses caused by reducing vapor pressures.

It is my belief that within these suggestions is not only an economically-viable clean air agenda, but also the potential to reduce caroon dioxide releases from the transportation sector by 20% by the year 2020. Additional information on this issue is included in my written testimony.

That concludes my testimony. Thank you again for this opportunity.

Mobile Source Pollutants' Reduction Matrix*
Motor Fuel Composition (By Volume)

Pollutant	10% Ethanol	20% ETBE	15% MTBE	M-85	E-85
(1) Carbon Monoxide	22-30%	20-30%	15%	90%	90%
(2) Ozone					
- Unburned Hydrocarbons (UHC)	10-15%	10-15%	10-15%	50%	50%
- Nitrogen Oxides (No_x)	+2%	neutral	neutral	+200%	+100%
- Photochemical Reactivity Index (UHC + BTX)	54-59	78-83	50-66	150	150
- Volatility Index	neutral	11%[2]	neutral	neutral	neutral
(3) Aromatics (BTX) [Benzene Emissions + Photochemical Reactivity]	44%	68%	40%	100%	100%
(4) Carbon Dioxide[3] (Greenhouse Gas Minimization)					
- Mass Percent Carbon[4]	4.3%	4.6%	4%	51%	36%
- CO2 Extraction Function [Renewable Biomass Effect]	2.7%	2.7%	0%	0%	23%
Net CO_2 =	7%	7.3%	4%	51%	59%
(5) Aldehydes					
- Formaldehyde (toxic)	neutral	no increase	slight increase	+100%	no increase
- Acetaldehyde (non-toxic)	slight increase	slight increase	neutral	neutral	slight increase

[1] Source: *Potential Emissions & Air Quality Effect on Alternative Fuels*, Nov. 30, 1988; Sierra Research, Inc., Sacramento, CA.

[2] Adding 20% of a 4-psi Rvp additive to a 9-psi Rvp gasoline = an 8-psi Rvp fuel - 11% reduction.

[3] Source: *Ethanol Fuel and Global Warming*, CRS Report for Congress, March 6, 1989. Net of all production input of CO_2 (e.g. planting, mining, harvesting, ethanol production, etc.)

[4] Source: *Automotive Fuels for the 1990s – Challenges and Opportunities*, Joseph M. Colucci, General Motors Research Laboratories, at the 1989 DeWitt Petrochemical Review, Houston, March 28-30, 1989.

*Assumptions: Oxygenated fuels blended with a 9 psi Rvp, 93-octane, all-hydrocarbon unleaded gasoline.

DRAFT

FARM ETHANOL - TIME FOR A NATIONAL POLICY
SUMMARY

This report calls for a greatly expanded ethanol industry accompanied by a Strategic Ethanol Fuel Reserve and a Strategic Processed Feed Grain Reserve. The rationale for this Program is:

o Projections reveal that increased U.S. dependence on imported oil from unstable regions of the world presents a serious energy security problem. Domestically produced ethanol reduces this problem.

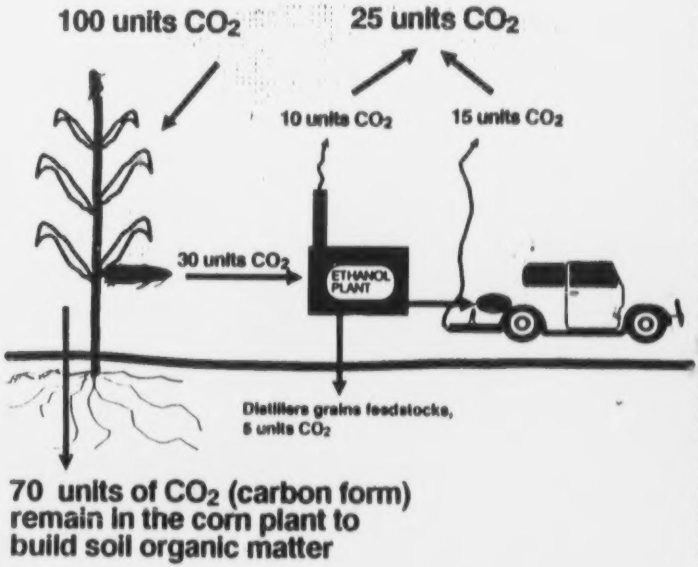
o The octane and oxygen benefits of ethanol contribute significantly to reduced levels of carbon monoxide and unburned hydrocarbons; but a high vapor blending pressure adds to evaporative emissions. Consequently, this Program calls for a transition to ethyl tertiary butyl ether (ETBE) which is made from ethanol. ETBE keeps ethanol's octane and oxygen advantages while greatly lowering the blending vapor pressure. This, and its favorable distillation curve, as well as the ease with which ETBE can be included in the refining, distribution, and marketing of gasoline, makes it a superior addition to the nation's gasoline pool.

o Much of the nation's octane needs are now being met by aromatic hydrocarbons, some of which are either carcinogenic or highly photochemically reactive. Pressures are mounting to reduce the levels of these chemicals in gasoline. ETBE is an excellent replacement.

o There is mounting concern over the build-up of carbon dioxide in the atmosphere. Ethanol is made from plants which get their carbon from the atmosphere. When ethanol is produced and combusted, it returns the carbon it received from the plants to the atmosphere. This movement of carbon from the air, to plants, to ethanol, and back to the air is part of the natural carbon cycle. Ethanol helps limit the build-up of carbon dioxide in the atmosphere and the resulting global warming by replacing fossil motor fuels that do increase CO_2 levels in the atmosphere.

o If ethanol feedstocks are grown on lands practicing sustainable agriculture, organic matter (about 50% carbon) can be built up in the soil thereby offsetting the combustion of fossil fuels. This carbon is removed from the air as carbon dioxide and moved to storage in the soil in the form of organic matter through natural processes involving photosyntheses and soil microorganisms.

o A greatly expanded Farm Ethanol Program would have major and positive impacts on the economy of rural America without adding to the problems of farm program outlays. The ethanol and processed feed grain reserves provide opportunities to optimize production during good harvests and provide products for the marketplace during poor harvests.


100 units CO₂
25 units CO₂
10 units CO₂
15 units CO₂
30 units CO₂
ETHANOL PLANT
Distillers grains feedstocks, 5 units CO₂
70 units of CO₂ (carbon form) remain in the corn plant to build soil organic matter

THE CORN PLANT - ETHANOL - CO2 - CYCLE

Bill Holmberg and Neal de Snoo

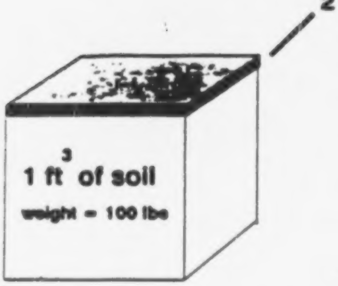
To optimize the process performance, five factors are essential: 1) rotate corn with a legume like alfalfa or clover; 2) credit the rumen by-pass characteristic of distillers grains; 3) combine distillers grains with legumes (and other nutrients) to form a total mixed ration as Lee Reeves does - integrated corn and alfalfa, ethanol, cattle feed lot, fish growing and top soil building operation in Garden City, Kansas; 4) incorporate manures, green manures, and other organic matter into the soil: and, 5) follow correct procedures in applying chemical/biological fertilizers/pesticides.

Using these procedures, it will be possible to increase organic matter in 120 million acres by 450 pounds/acre/year and offset the combustion of 10 billion gallons of gasoline per year - see following pages.

Using a fraction of these 120 million acres to grow feedstocks for ethanol will provide 10 billion gallons of ethanol per year.

These two factors - building organic matter, and using ethanol - offers a 20 percent solution to the CO2 build-up problem in the transportation sector (U.S. uses 100 billions gallons of gasoline annually).

SOIL – YEAR ONE



2 % organic material *

=

1% carbon

=

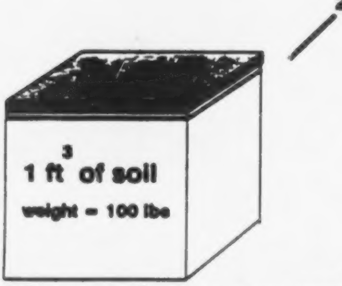
1 lb of carbon/ft^3

1 ACRE = 43,560 FT^2 X 1 FT = 43,560 FT^3

43,560 FT^3 X 1 LBS/FT^3 = 43,560 LBS OF CARBON/ACRE

* Soil organic matter could be at any initial percentage at Year 1. The improvement rate is the critical factor. Generally, the higher the level of organic matter in the soil, the more difficult it is to increase that level.

SOIL – YEAR ELEVEN



2.2% organic material

=

1.1% carbon

=

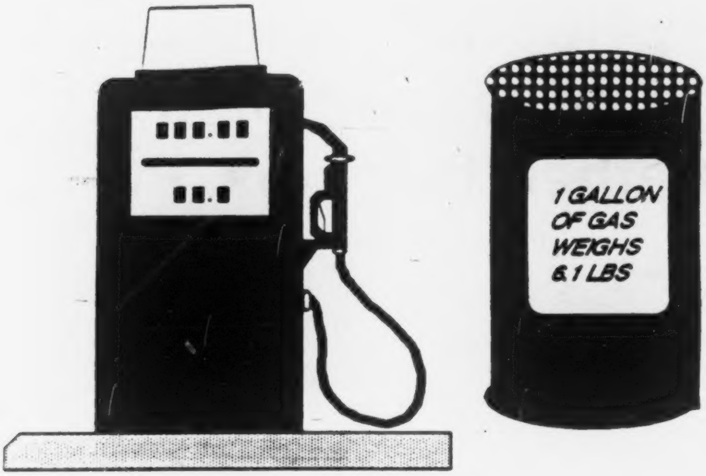
1.1 lbs of carbon/ft^3

43,560 FT^3 X 1.1 LBS/FT^3 = 47,916 LBS OF CARBON/ACRE

47,916 LBS OF CARBON IN YEAR ELEVEN
43,560 LBS OF CARBON IN YEAR ONE

4,356 LBS OF CARBON GAINED OVER TEN YEARS

OR, $\frac{4,356}{10}$ = 436 LBS OF CARBON INCREASE/YEAR
BY INCREASING ORGANIC MATERIAL
AT THE RATE OF .02%/YEAR



I LB OF GASOLINE COMBUSTS INTO ABOUT 3.2 LBS OF CO_2

6.1 LBS OF GAS X 3.2 LBS CO_2/LB OF GASOLINE = 19.52 LBS/CO_2

19.52/44 (molecular weight of CO_2) = X /12 (molecular weight of carbon)

X = 5.32 LBS OF CARBON RELEASED IN THE COMBUSTION OF ONE GALLON OF GASOLINE

ONE ACRE WITH ORGANIC BUILD – UP (.02%/YR)
REMOVES 436 LBS OF CARBON

(436 LBS/CARBON ACRE/YR) / (5.32 LBS/CARBON/GAL. OF GAS)

= 82 GALLONS OF GASOLINE/ACRE/YEAR

82 GAL/ACRE X 120 MILLION ACRES

=

9.8 OR 10 BILLION GALLONS OF GASOLINE/YEAR

Agricultural Productivity as the Solution Rather than the Problem

Demand Enhancement as an Alternative to Supply Control Policy

Briefing Document Prepared by E.C.A. Runge[1] for Discussions
with Secretary of Agriculture Clayton Yeutter
and Members of Congress
May 3, 1989

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[1] E.C.A. Runge is Professor and Head of the Department of Soil and Crop Sciences, Texas A&M University, College Station, Texas 77843-2474, (409)845-3041; 1989 President, American Society of Agronomy; and 1985 President, Soil Science Society of America. The contributions, interaction, and assistance of J.B. Penson, S.H. Murdock and D.I. Padberg in preparing this document is gratefully acknowledged -- All are professors at Texas A&M. Penson is Stiles Professor of Finance in Agr. Economics; Murdock is Head of Rural Sociology; and Padberg is Head of Agr. Economics.

TABLE of CONTENTS

BRIEFING DOCUMENT - Agriculture as the Solution Rather than the Problem ....1. Briefing Document

DEMAND ENHANCEMENT AS A SINK FOR EXCESS CROP PRODUCTION ....2. Appendix 1

IMPLICATIONS FOR AGRONOMISTS UNDER DEMAND ENHANCEMENT POLICIES ....3. Appendix 2

IMPLICATIONS FOR AGRONOMISTS UNDER PRESENT VOLUNTARY SUPPLY MANAGEMENT POLICIES ....4. Appendix 3

AGRICULTURAL POLICY, AGRONOMY AND RURAL DEVELOPMENT ....5. Appendix 4

U.S. AGRICULTURE IN A GLOBAL AGRICULTURAL ECONOMY ....6. Appendix 5

AGRICULTURAL PRODUCTIVITY AS THE SOLUTION RATHER THAN THE PROBLEM

Introduction/Goals:

1. The United States and World needs to strive for an agricultural policy that supports the development of an agriculture enabled by science that is also in harmony with environmental and human values.

2. U.S. agriculture must be as competitive as possible and have policies that enable U.S. and World agriculture to move in the direction of meeting long term need(s). Agricultural policy should be relevant to the present, position us for the future and be politically possible.

3. U.S. agriculture must strive to be competitive. Exports and trade must be encouraged. If government intervention policies are required, emphasis must be directed to achieve positive ends, including:

    a) Stabilizing farm production
    b) Conserving natural resources
    c) Maintaining payrolls in rural areas
    d) Developing energy alternatives
    e) Encouraging economic development in third world countries

4. U.S. agricultural policy should reward, and be recognized as rewarding, productivity rather than non-productivity. It should foster the development of technology and creativity to increase the supply of the World's goods and services while creating conditions that allow agricultural producers to remain in farming and rural America to foster an improved quality of life for its residents.

Issues Affecting U.S. Agriculture

1. Excess crop production capacity - Dennis Avery, World Perspectives, Inc. Washington, D.C. estimates that the world has 150 million metric tons of excess crop production capacity with 2/3's of that located in the United States (Appendix 5).

2. Variable climate has always been a risk assumed by farmers dependent on rainfed agriculture. If meteorological predictions are correct, future weather will be more variable than the weather we have experienced in the recent past. If that is the case, it will become increasingly hazardous to predict annual production of our major crop commodities.

3. Rural areas must have an increase in employment if their economic conditions are to improve. If U.S. agriculture could operate at its sustainable rate it would help maintain and perhaps create additional jobs in rural areas. This in turn would help maintain the human resource base and the infra-structure of rural areas.

4. U.S. farmers will only be competitive if we develop and they apply the latest technology available. Restriction of output will suppress the discovery and use of Biotechnology as well as other forms of technology.

5. Food, Fiber and Water Quality - American cititzens are much more concerned about the quality of their food and fiber supply than at any other time in history. Water quality is a major concern and any major agricultural production practice will have to pass increasingly stringent environmental tests.

6. Budget Deficit - The budget deficit limits options that can be considered. For any proposal to be considered, it must not increase negative impact on the budget.

7. Many countries still demand imports and will continue to do so, however, many nations are also becoming self-sufficient. Crop production has increased in many countries that were formerly importers of U.S. commodities.

Considerations:

1. Food and Fiber Supply - Food and fiber production has historically exceeded demand and has provided substantial surpluses for emergency situations -- droughts, etc. This excess could be used as a subsidized "sink" to produce energy or other products.

2. The capital investment in the "sink" would be much less than that needed to adjust production. The cost of bringing capacity on line and shutting it down would be much less than the cost of controlling production agriculture. Dislocation of rural resources would be much less.

3. If you can't predict climate, you cannot predict yield and supply. Under demand enhancement climatic variability and its influence on crop production would not cause food shortages since agriculture would produce at its sustainable level.

4. With agriculture operating at its sustainable level, the number of agriculturally-related jobs in rural areas would be maximized and stabilized.

5. Applicable technology from biotechnology and other research and development activities could be effectively utilized to increase the production and efficiency of agriculture.

6. Budget expenditures would be less and be more concentrated in areas within the U.S. than with present programs (EEP, ARP, CRP, etc). Agricultural subsidies would be allocated to operating the "sink" to produce energy products and providing rural jobs rather than dumping excess capacity on the world market or paying farmers not to produce.

7. World Trade - It should be possible for countries to cooperate on such a policy. Establishment of reserve supplies for food emergencies would be necessary before operating the "sink".

8. A limited number of crops would have to be designated as "sinks". The ethanol industry is able to use starch. Corn and wheat are grown over wide areas of the US and could be designated as the unregulated acreage crops for use in a "sink".

9. Farmers are aware that the amount of carry-over or ending stocks substantially affect prices. Any use of a crop commodity as a "sink" for excess crop production would have to ensure growers that the

price was based on the cost of production. Non-sink crops would be subject to normal supply/demand activity, price fluctuations, etc.

10. CO_2 Problem - Demand enhancement policies using designated crop commodities as "sinks" for excess production would maximize the amount of CO_2 taken up by plants and recycled.

Some questions needing evaluation:

1. What are the full range of costs and potential benefits from a demand enhancement program and how would such costs and benefits be distributed relative to existing programs?

2. How rapidly could such a policy be implemented and how long would it be before its impacts would become evident?

3. What are the best "sinks" to use in implementing such a policy and what are the relative costs and benefits associated with different sinks?

4. What would be the substitution effects among "sink" and "nonsink" commodities?

5. How substantial would the secondary and tertiary effects be of such a policy and in what regions of the Nation would they be concentrated -- such as the effects on the retention of producers and populations in rural areas, the impacts on jobs in rural areas, the effects on the infrastructure and tax base of rural areas, the net cost to the US taxpayer, etc.?

6. How would producers, commodity, environmental, and other interest groups, as well as the public respond to such a policy?

7. What effects would such a policy have on the domestic petroleum industry and other U.S. and foreign industries?

Implications of Supply Control and Demand Enhancement *

Supply Control Policies	Demand Enhancement Policies
Implications for Crop Producers	
■ Higher commodity prices	■ Higher commodity prices
■ Lower stocks	■ Lower stocks
■ Extend life of existing machinery	■ Shorter life of existing machinery
■ More intensive use of yield enhancing inputs per acre	■ Greater use of new technologies and purchase additonal resources
■ Fewer total purchased inputs	
Implications for Livestock Producers	
■ Higher feed prices	■ Higher feed prices
■ Feed supplies more vulnerable to weather shocks	■ Feed supplies less vulnerable to weather shocks
Implications for Domestic Consumers	
■ Higher food prices	■ Higher food prices
■ Food supplies more vulnerable to weather shocks	■ Food supplies less vulnerable to weather shocks
Implications for Foreign Trade	
■ Higher world prices	■ Higher world prices
■ Lower exports	■ Higher exports under export enhancement
	■ Lower exports under domestic enhancement
Implications for Input Supply Manufacturers	
■ Reduced demand for machinery and equipment	■ Expanded demand for machinery and equipment
■ Reduced demand for chemicals, fertilizer and seed	■ Increased demand for chemicals, fertilizer and seed
Implications for Environment	
■ Reduced use of marginal lands	■ Greater use of marginal lands
■ Less groundwater pollution and fewer chemical residues	■ More groundwater pollution and greater chemical residues
Implications for Rural Communities	
■ Reduced sales by agri-business firms	■ Expanded sales by agri-business firms
■ Lower hired labor force in agriculture and agri-business	■ Increased hired labor force in agriculture and agri-business
■ Reduced rural economic activity and tax base	■ Expanded rural economic activity and tax base
Implications for Government	
■ Higher U.S. Treasury costs	■ Lower U.S. Treasury costs
■ Lower economic activity in food and fiber sector leads to lower GNP and tax revenue and higher budget deficits	■ Greater economic activity in food and fiber sector leads to higher GNP and tax revenue and lower budget deficits
■ Increase risk of slippage due to biotechnologies	

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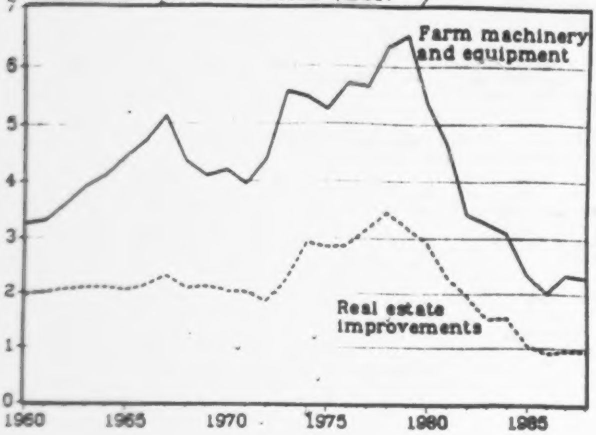
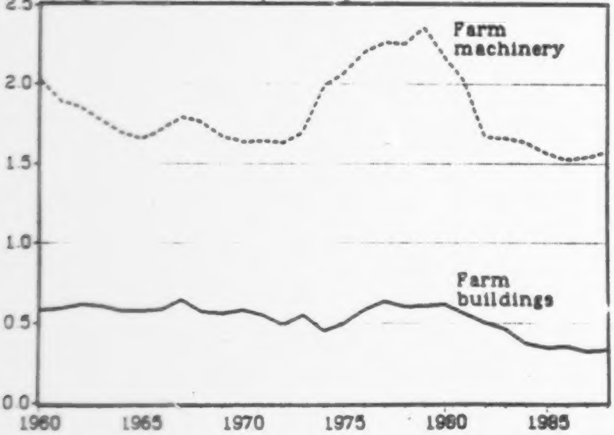
* From Penson, J.B. and J.W. Richardson. Implications for Agronomists Under Demand Enhancement Policies. Given at American Society of Agronomy Meeting, Anaheim, California, November 30, 1988. To be published in the Journal of Production Agriculture. -- Appendix 2.

Real Gross Investment in Selected Farm Capital Items (Bil.*)



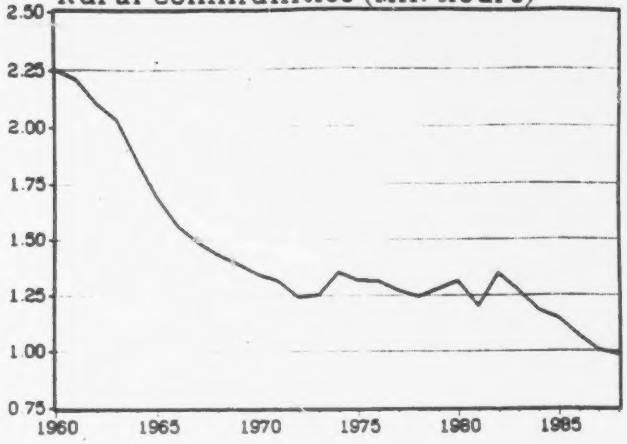
*Constant 1967 Dollars

Real Repairs to Selected Farm Capital Items (Bil. *)

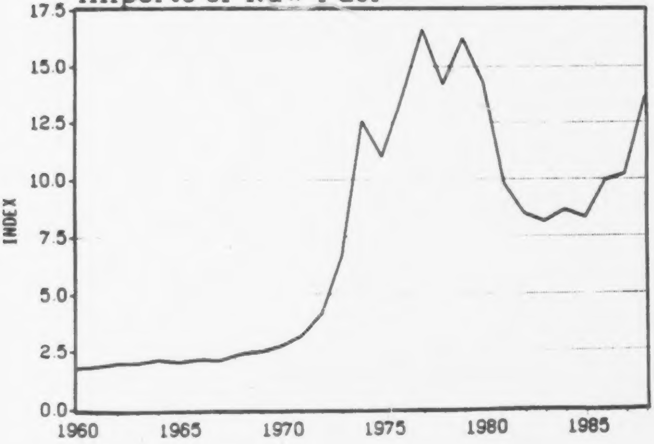


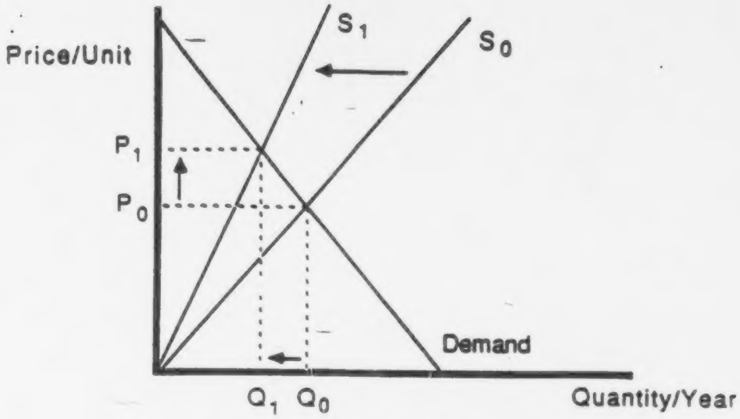
*Constant 1967 Dollars

Labor Supplied to Agriculture by Rural Communities (Mil. Hours)

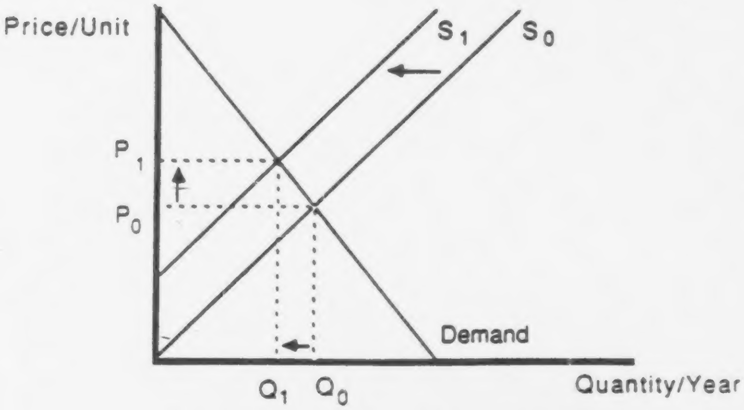


Imports of Raw Fuel





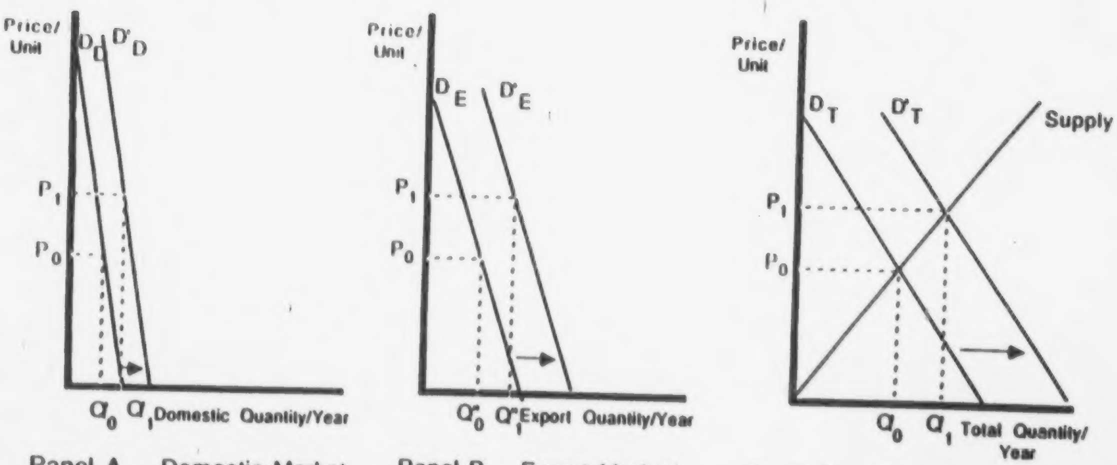
Panel A. Short-Term Production Controls.



Panel B. Long-Term Acreage Control

Figure 2. Comparison of Short-Term Production Controls and Long-Term Acreage Controls Impacts on Quantity Produced and Price *

*See Penson, J.D. and Richardson, J.W. Appendix 2



Panel A. Domestic Market Panel B. Export Market Panel C. Total Demand and Supply

Figure 3. Effects of Domestic and Export Enhancement Programs

on Total Demand, Price, and Quantity Consumed *

* See Penson, J.D. and Richardson, J.W. Appendix 2

Appendix 1

DEMAND ENHANCEMENT AS A SINK FOR EXCESS CROP PRODUCTION

E.C.A. Runge, Steve Murdock, J.B. Penson, D.I. Padberg and B.A. Stout

ABSTRACT

The USA needs to develop an agricultural policy that is enabled by science and in harmony with environmental and human values. Such a policy needs to provide direction to all people and industries involved in agriculture, to move USA agriculture in the direction of long-term need, and to be as economical as possible. It should also take into account other problems impinging on agriculture such as the increase in atmospheric CO_2, trade deficit, rural area decline, and the budget deficit. The alternative policy discussed is the development of a sink for excess production. The sink is a way to utilize excess grain. Such a concept, if adopted, offers an alternative to subsidized exports and some of the acreage reductions for crop commodities. Crops should be planted only on land not susceptible to excess erosion. It seems better to pay farmers to produce a renewable resource by growing a crop than to pay them to take land out of production if the cost is the same or less. It may be possible to cooperate with other exporting countries under such a policy. Policy-makers need to look to agriculture as a way of solving problems facing the USA rather than being a problem.

DEMAND ENHANCEMENT AS A SINK FOR EXCESS CROP PRODUCTION

E C. A. Runge, Steve Murdock, J.B. Penson, D.I. Padberg, and B. A. Stout[1]

INTRODUCTION

We are pleased to discuss DEMAND ENHANCEMENT AS A SINK FOR EXCESS CROP PRODUCTION. To set the stage for our discussion it is necessary to review some of the assumptions we have made concerning present agricultural policies and the conditions of agriculture. Then we will discuss one example of a form of demand enhancement to demonstrate the impact that an alternative agricultural policy might have for United States agriculture and rural areas.

Current U.S. Agricutural Policy relies on market/trade driven supply control concepts that are presumably based on a commitment to a world-wide free market for agricultural commodities and goods. US policies have become increasingly focused on attempts to control supplies of agricultural commodities through acreage reduction and the enhanced export program (EEP) (See Table 1). Through EEP we have subsidized exports of commodities (dumped) on world markets to reduce the domestic surplus and gain market share. This practice hurts other economies with significant agricultural exports. Not only is the reality of our agricultural policy contrary to our free-market philosophy, it has also been largely ineffective in meeting the long-term goals for U.S. agriculture or rural America.

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[1] The authors are professors in Soil and Crop Sciences, Rural Sociology, Agricultural Economics, Agricultural Economics and Agricultural Engineering at Texas A&M University, College Station, Texas 77843, respectively. Runge, Murdock and Padberg are also Heads of Departments and Penson is Stiles Professor of Finance. Use of Congressional Research Service Report for Congress 88-71 SPR titled "Analysis of Possible Effects of H.R. 2031, Legislation Mandating Use of Ethanol and Methanol in Gasoline", prepared at the request of the Honorable Bill Alexander, Congressman from Arkansas, by Midgon R. Segal, A. Barry Carr, Bernard A. Gelb, David E. Gushee, James E. Mielke and Michael M. Simpson, and dated November 17, 1987 is gratefully acknowledged as is the contribution of R.D. Lacewell, Professor of Resource Economics, Department of Agricultural Economics, Texas A&M University, College Station, Texas. Paper was given at the Western Agricultural Economics Association, Summer Meeting, Honolulu, Hawaii, July 12, 1988.

In addition, agricultural policies have become increasingly expensive, detrimental to the economic well-being of agricultural-related industries and subject to an increasing array of economic and environmental criticisms. One year ago our farm programs were costing roughly $25 billion per year and resulted in the removal from production of approximately 25% of our corn acreage (See Table 1 for corn). This, in turn, negatively impacts input supply industries and rural areas where many of these industries are located. The 1988 drought has reduced the cost of our farm programs this fiscal year below projections.

Admittedly reliance on conventional market trade supply policies are very appealing from an ideological perspective. However, the policies have not worked historically because of 1) the tendency of many nations to intervene, 2) the tendency of farmers to idle marginal lands first and to crop their better lands more intensively and 3) the biological nature of crop production and yearly climatological variations, which makes agriculture inherently more unstable than other sectors of our economy.

Agriculture is also among the most technology-intensive industries in the world. Supplies have increased substantially because of the use of technologies whose introduction is largely unregulated by government policy and, in fact, is subsidized by the government (e.g. Support of agricultural research and extension). A majority of agricultural scientists would not criticize the use of such technology, recognizing that it generally provides a competitive advantage to early adopters, but projecting the impacts of the introduction and use of technology on supplies is difficult. Thus, technology further increases the difficulties entailed in estimating world supplies of commodities, which is a central part of our present agricultural policies.

We conclude that US agricultural policies of controlling supplies have been ineffective and produced effects that are contrary to intentions. Many factors have led to this conclusion, but among the most important are:

1. Agricultural production is affected by variable and unpredictable patterns of weather that make prediction of supplies impossible.
2. Many other nation's agricultural policies are not market oriented and thus respond to forces in addition to the market, and
3. Agriculture is among the most technology intensive industries and the diffusion of that technology has become increasingly international in scope and continues to increase production.

If we further conclude that most nations of the world will not quickly adopt our proposed free-trade policy, that weather will remain variable and unpredictable, that technological impacts are likely to become more frequent (And may, in fact, increase substantially with the use of biotechnological products), and that existing farm policy is likely to come under an increasing number of economic and environmental criticisms, it appears that a search for alternatives to present US policy is timely.

U.S. AGRICULTURE NOW

Present U.S. Agricultural Policy enables us to produce crops for internal use, for export and for storage. An undetermined amount of crop commodities in storage is desired to even out production between poor and good weather years. To further reduce production, we have taken acreage out of production. In 1988, approximately 25% of U.S. crop production acreage was idled because it was not needed internally and there was not sufficient demand for additional exports.

U.S. agriculture is hobbling along at the present time because we have excess capacity (or too few want to buy what we have to sell) and because we have not decided how to develop a long-term policy that is economical and will satisfy the numerous, and often conflicting demands of producer, commodity group, consumer, environmentalist and other groups involved in formulating agricultural policy in the U.S. We are joined in this dilemma by most nations exporting agricultural commodities. Conditions of excess crop production capacity are expected to continue here and elsewhere for the foreseeable future. Dennis Avery, Senior Agricultural Analyst with the U.S. State Department in a speech before the Delta Council, Starkville, Mississippi, Fall 1988, estimated the World has 150 million tons of surplus capacity. Consequently, we need to examine if producers of agricultural commodities, where production is subject to the vagaries of the weather as well as the U.S. economy, would benefit under some alternative policy.

It is obvious that the U.S. lacks a clear policy on what we expect our agriculture to do for us. The lack of a clear policy, to help focus where we want U.S. Agriculture to be 5 or 10 years hence, could lead to increasingly more expensive and more chaotic conditions for individual operators than is necessary or desired, particularly when the operating units are dispersed, small or highly leveraged and production is weather dependent. It could also lead to higher than necessary costs for the U.S. treasury as well as lost opportunities for many people. Present U.S. agricultural policy assumes that crop commodity producers can compete on the export market with producers living in countries with policies having different objectives than those in the U.S.

As the 21st Century approaches, we recognize that the fundamentals on which economic and science policy for agriculture, natural resources and rural development rest are changing. Biotechnology and computers have increased world-wide scientific and economic integration; we have a heightened awareness of food safety and we are all concerned about the environment. Congress is increasingly concerned about the viability of rural communities and all of these concerns impact on the kind of agriculture and the kind of agricultural policy we must have to attain our goals.

AGRICULTURAL POLICY AND OUR FUTURE

Obviously, today's agricultural problems are tomorrow's challenge so let us discuss our future. The diffuse producing units of U.S. agriculture would benefit from a long-term (10 or more years) U.S. agricultural policy that individual owners and operators could rely on in making decisions for their farming unit. Would policies that expand internal demand in the USA and elsewhere to help utilize excess agricultural production lead to a more stable long-term policy? This and other policy alternatives need to be compared to the supply control and export policies that are the backbone of our present policy. Any alternative policy needs to position U.S. agriculture to be internationally competitive in the years ahead but agricultural policy must also promote AN AGRICULTURE THAT IS ENABLED BY SCIENCE AND IN HARMONY WITH ENVIRONMENTAL AND HUMAN VALUES.

If we examine present agricultural policies of countries around the world, some similarities can be identified. Every country wants ENOUGH AGRICULTURAL PRODUCTION TO PROPERLY FEED AND CLOTHE THEIR PEOPLE. They also want to produce as much of their own crop and livestock production as they can even if it costs more than importing the same commodities. Such a policy is desired because it reduces foreign currency needs, provides employment and allows individual countries to be more self-reliant.

Agricultural policy in virtually all countries is conditioned by weather uncertainty. Since crop production is weather dependent, we must necessarily have enough production in storage from good weather years to see us through in poor weather years if we are to feed and clothe people adequately. The 1988 drought was mitigated by commodities in storage. We must also recognize that if we design our agricultural policies so supplies are ample in average or below average weather years (We would rather have too much than not enough.) we will have excess production in good or in normal weather years. Excess production occurs and leads to a need to expand exports and/or impose acreage controls to support price. This need to have a prudent amount of commodities in storage, plus increased yields per acre have led to over-production and our preoccupation with free trade and competition to gain export market share.

Under present policies we have opted to heavily subsidize exports by paying the difference between target and market price for crop commodities in order to reduce stocks in storage rather than to expand demand. For corn, for much of 1987/88, for example, the target price was $2.93 and the market price was about $1.69 for a difference of $1.24 per bushel which was the subsidy we paid to export corn in 1987. Similar export subsidies apply to many other crops. We are also curtailing production by various acreage set-a-side programs (See Table 1).

If we are objective, we must admit that there is not enough traditional demand for what we and other crop commodity exporters can produce. Also, our export subsidy drives down the world price for the commodity being exported. These policies lead other nations to accuse

THE RICH U.S. of forcing (dumping) grain into the export market at the expense of other often poorer nations that desperately need to sell their excess grain to obtain precious foreign exchange. Some would say this is a curious way for the U.S. to spend its money, particularly when through USAID programs we have been most generous in helping less-developed countries to become self-sufficient Also, we agriculturists need to assume that export dumping can not be forever justified to Congress. Can we devise a better alternative?

Present U.S. agricultural policy utilizes crop production to supply normal channels of commerce in the U.S. and to supply exports. We have also developed elaborate facilities to store excess production for use in poor weather years. For example, ending stocks of corn for 1986/87 was 4.88 billion bushels. From 1983/84 to 1987/88 ending stocks of corn varied from 1.01 to 4.88 billion bushels (Table 1). Since we have considerably more crop commodities in storage than needed, acreage control policies have been developed to help curtail excess crop production. The 1988 drought reduced ending stocks of corn to an estimated 1.407 billion bushels and acreage set-a-sides for 1989 crops are being evaluated as this is written.

Set-a-side acreages are often made politically palatable by inferring that we are saving our precious topsoil for future generation. A worthy objective that we can all subscribe too. Some do not believe that this is necessarily so, but we strongly advocate that agricultural production must be enabled by science, must be sustainable, and must be in harmony with environmental and human values. All things being equal it seems logical to us that it would be better to pay farmers to produce a renewable resource by growing a crop that has some use, even if uneconomic, than to pay the same amount or more to idle land and produce nothing of value. Such a policy would have positive impacts on rural development.

What about the future? One potential alternative policy for future consideration is THE DEVELOPMENT OF A SINK FOR EXCESS CROP PRODUCTION as a substitute for subsidized exports as the way to dispose of excess grain and acreage set-a-sides to curtail production. The SINK would convert excess agricultural production to products useful to the U.S. Under such a scenario, the U.S. would produce food and fiber for normal U.S. channels of commerce, for unsubsidized exports and for "reasonable" storage. Production beyond these needs would be utilized by the proposed SINK.

To be seriously considered, the cost of operating such a SINK must be no more expensive, and hopefully less, than the 1987/88 cost of our export subsidy ($1.24 per bushel of corn exported). The only SINK large enough at the present time to absorb excess U.S. crop production capacity is the ethanol and/or chemical feed stocks industry. It seems inherently reasonable to us that the SINK concept for crop commodities is superior (less costly and less disruptive) to our present policy of highly subsidized exports and costly acreage set-a-side programs. It would also start us on a path of supplying part of our energy needs from renewable instead of fossil sources, help us diminish the impact of the next energy crisis and help reduce the rate of increase of CO_2 in the atmosphere.

Any excess crop production capacity as well as the variation in crop production caused by yearly weather fluctuations would be absorbed by the SINK. It is reasonable to assume that yearly ethanol production could be stabilized somewhat by grain flow in or out of storage. Such use of our elaborate storage system should permit stable and more nearly optimum use of capital intensive ethanol production facilities. Also it is less expensive to adjust production capacity of ethanol plants than it is to adjust capacity of capital intensive crop production units such as we are doing with acreage set-a-side programs. We feel we can argue successfully that the U.S. should develop an agricultural policy that relies on renewable resources to the extent that it is economically, environmentally, and agronomically feasible to do so.

A POSSIBLE SCENARIO

Obviously any proposed agricultural policy must be economically competitive with present policy to be seriously considered. It needs to be fully studied and debated whether or not excess supply utilization and demand enhancement policies, such as using crop commodities for chemical feedstocks, is a viable alternative. The adoption of such a policy would more than likely lead to more economic conversion processes of crop commodities or to higher value end-product uses over time. Further comprehensive studies are needed and must include all aspects of the economy that are impacted by agricultural policy including rural development.

Let's examine if excess supply utilization and demand enhancement using corn is cost competitive with present policies. For example, if the 1.7 billion bushels of corn (Table 1) that we exported in 1987/88 with a subsidy of $1.24 per bushel ($2.93 target price less $1.69 market price, does not include Public Law 480 export costs.) were converted to ethanol it would produce 4.25 billion gallons of ethanol at the conversion rate of 2.5 gallons of ethanol per bushel of corn. The present U.S. subsidy on ethanol is $0.60 per gallon, so the cost of converting 1.7 billion bushels of corn to ethanol is $2.55 billion to produce 4.25 billion gallons of ethanol. The ethanol produced has a gasoline value of $1.7 billion for a net cost of $0.85 billion. If used as an octane enhancer, the ethanol would have additional value. With these figures the ethanol demand enhancement program costs $1.26 billion less than what was spent for enhanced exports (1.7 billion bushels x $1.24 per bushel subsidy=$2.11 billion total export subsidy). Choosing this policy would not stop exports but it is better than dumping our excess crop production on world markets at the expense of poorer 3rd World Countries (See Figures 1 & 2 for relationships).

There is debate among us whether or not the cost of converting corn to ethanol is only $0.60 per gallon. Various states subsidize ethanol production and much of the ethanol produced may be sold in those states. Consequently ethanol conversion costs could be higher. At least one documented study suggests that ethanol production is profitable with $3 per bushel corn when the subsidy for ethanol is $0.85 per gallon. If such costs are more correct, (We believe an $0.85 per gallon subsidy is high.) the $2.55 billion cost for converting 1.7 billion bushels of corn to 4.25 billion gallons of ethanol in our example would be $3.6 billion. With an ethanol gasoline credit of $1.7 billion, the net subsidy cost is $1.9 billion - still $0.2 billion less than the $2.1 billion paid during 1987/88 to subsidize the export of corn.

FUTURE CONSIDERATIONS

Annual U.S. gasoline consumption is approximately 100 billion gallons so there is the potential to use up to 10 billion gallons of ethanol if blended to make gasahol that is 90% gasoline and 10% ethanol. We could not supply this amount of corn to the chemical feedstocks industry as well as supply domestic needs and unsubsidized exports under current technology in a sustainable and environmentally acceptable way with current production practices even if acreage controls were lifted. Corn production could be increased by shifting production from other crops to corn. Shifts between corn and other crops would depend on relative prices between commodities and the net profit expected from producing the crop. Also, present ethanol production capacity is approximately 800 million gallons per year (See figure 1) and time would be needed to install additional production capacity.

We have not developed cost comparisons but the relationships are given by extrapolation from those discussed under A POSSIBLE SCENARIO section and represented in figure 2. In figure 2, exports are reduced to 0.7 billion bushels and ethanol use is increased by 1.0 billion bushels over that in figure 1. In figure 3, we have developed a demand enhancement example by increasing corn production by 1 billion bushels and decreasing set-aside by 10 million acres. It is not the purpose of this paper to discuss shifts in acreage between crops, to fine tune any particular example, or to discuss all sector impacts such policy changes would create. It is clear to us that we do have alternative agricultural policy possibilities that should be evaluated.

Obviously the cost of operating an ethanol program will vary depending on the price of corn. Policy can determine price at least to a degree. We concentrated only on converting corn that is exported to ethanol because we could identify the $1.24 per bushel subsidy and make relatively concise comparisons. Obviously, the time period selected will affect the price of corn and cost comparisons. Also, some exports will take place irrespective of the price of corn, hence our figure 2 example. It is our contention that an ethanol SINK for using excess crop production does not need to increase food costs per se, to substantially interfere with internal use and exports of corn, or to replace present market and target price policies.

Such an ethanol SINK does present an alternative that needs thorough evaluation. The possibility exists that costs to the U.S. government could decrease substantially depending upon how the costs are partitioned between the government, farmers and consumers. Regional adjustments may vary but policies could reduce or minimize negative sector impacts. Successive, or should we say progressive, changes over a period of years could seemingly enable U.S. agriculture to operate with reduced acreage restrictions and with substantial economic benefit.

Another positive aspect of such a policy is that 4.25 billion gallons of ethanol would save between 245,000 and 255,000 barrels of oil imports per day, thereby helping our balance of payments by approximately $1.65 billion at $18 per barrel oil. Ethanol produced from corn would impact positively on the CO_2 build up problem. It would also help control air pollution in some of our major cities. For example, Denver mandates the sale of gasahol within the city during parts of the year to improve air quality. Clearly, the potential to use considerably more ethanol is available if cost, policy and other factors impacting on production are positive.

If we really got serious about adopting demand enhancement as a major part of U.S. agricultural policy it should impact positively on rural development which is a major concern of the present Congress. It is likely to have positive impact on other countries world-wide and we would not be accused of dumping. Other major commodity exporters could be encouraged to develop "SINKS" for their portion of excess crop production as well. Cost, commodity displacement, and sector impacts, etc. need careful study. Ethanol production may not be the most economical use of corn if reliable supplies were available for use in the chemical feedstocks industry. More economic industrial uses of corn products than ethanol will only come with stable supplies and a research development program designed to make use of these supplies.

The development of a demand enhancement policy is also likely to have secondary and tertiary impacts that are predominantly positive. Although the development of ethanol would likely lead to some displacement of workers from the crude oil refining and export sectors and would require subsidization of the ethanol industry with present cost relationships, we anticipate that analyses of impacts of this policy will show positive impacts on the economic, demographic, public service, fiscal and social dimensions of agriculturally dependent rural areas in the United States. For example, the negative impacts on the oil industry could be offset by an oil import tax that could be utilized to pay for the production of ethanol. Whereas present policies have contributed to the loss of more than 4.0 million farms and more than 25 million persons from the rural farm population since 1930, we believe that the proposed policy (or similar policies) would reduce the rate of farm and population decline. The economic activity and employment associated with increased agricultural production would stabilize agricultural input industries and other businesses in rural areas and likely positively impact income stability in producer households. Such conditions would, in turn, likely lead to the retention of more producers' and secondary workers' households in rural communities. These increased service populations, together with increased economic activity and associated income, would also likely positively affect rural services and the tax bases of rural areas, that are presently feeling the impact of reductions in the value of farm lands and other natural resources. Although the exact nature of such secondary and tertiary impacts require much more extensive analysis, we believe that assessments of agricultural policy must include evaluations of their impacts on socioeconomic conditions in rural areas and that demand enhancement policies are likely to have positive impacts on such conditions.

The adoption of agronomic and biotechnologic crop production technology will be slowed under present supply control policies compared to what they would be under demand enhancement policies. For example, college students enrolled in agronomic as well as in many other agricultural disciplines have decreased as a result of the slump in U.S. agriculture and the commensurate decrease in suitable employment opportunities. The rate of technology development and adoption will be negatively impacted by the reduced talent base employed in agricultural positions. U.S. and World agricultural policy makers need to be aware that technology development and adoption in the future will be negatively impacted by these trends.

SUMMARY AND CONCLUSION

In this paper, an agricultural policy that develops a SINK for excess crop production and that may offer an attractive alternative to present policy has been described. Such a demand enhancement policy would attract more talent to agricultural occupations and should speed technology development and adoption.

A well thought out U.S. agricultural policy should also take into account rural development. Other countries, particularly in Europe, utilize agricultural policy as a instrument for rural development. Stability in U.S. agricultural policy would be very positive for agriculture world-wide and would enhance the adoption of technology. In addition, it would help develop a U.S. agricultural industry that is ENABLED BY SCIENCE AND IN HARMONY WITH ENVIRONMENTAL AND HUMAN VALUES.

The policy alternative proposed above clearly requires additional analysis. As proposed, however, we believe it may provide a number of advantages for the nation. It would allow our crop production capacity to be usefully employed. It would provide a "SINK" that is sufficiently flexible to respond to variations in weather, technology and other factors affecting supplies. It would help reduce our dependence on foreign energy imports and assist in addressing the budget deficit. It would help retain people in agriculturally dependent rural areas and thus assist in enhancing a better quality of life in rural America. Although, no one policy alteration is sufficient to address all of the Nation's policy needs related to agricultural production, the need to seriously consider alternatives is evident. We believe the alternative proposed here as well as others should be considered as we seek to establish an agricultural policy that is good for American Agriculture, good for rural America, good for environmental quality, and good for the fiscal stability of the United States.

If we all put our heads together I am sure we can come up with a better and more economic agricultural policy than the present one.

Table 1 - SUPPLY & UTILIZATION OF CORN (FROM AGRICULTURAL OUTLOOK)

	-------Acres-------											
	Set Aside	Planted	Harvested	Yield	Production	Total supply	Feed and Residual	Other domestic use	Exports	Total use	Ending stocks	Farm price
		Mil. acres		Bu/acre				Mil. bu				$/bu
Corn												
1982/83	2.1	81.9	72.7	113.2	8,235	10,772	4,521	894	1,834	7,249	3,523	2.55
1983/84	32.2	60.2	51.5	81.1	4,175	7,700	3,818	975	1,901	6,694	1,006	3.21
1984/85	3.9	80.5	71.9	106.7	7,674	8,684	4,079	1,091	1,865	7,036	1,648	2.63
1985/86	5.4	83.4	75.2	118.0	8,877	10,536	4,095	1,160	1,241	6,496	4,040	2.23
1986/87	13.6	76.7	69.2	119.3	8,253	12,294	4,717	1,191	1,504	7,412	4,882	1.50
1987/88	21.6	65.7	59.2	119.4	7,064	11,948	4,900	1,225	1,700	7,825	4,123	1.94
1988/89	21.3										1,407	2.60*

* USDA Estimate

Figure 1. 1988 expected relationships.

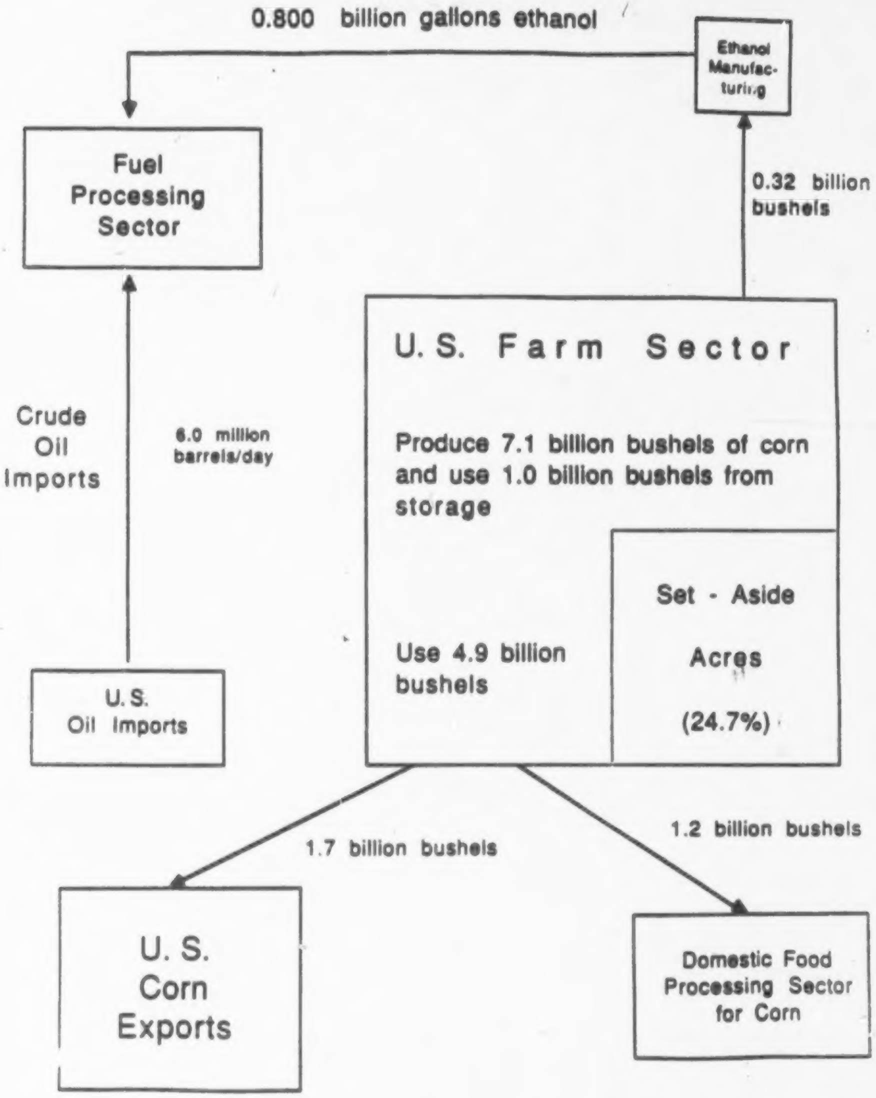

0.800 billion gallons ethanol
Ethanol Manufacturing
Fuel Processing Sector
0.32 billion bushels
U.S. Farm Sector
Produce 7.1 billion bushels of corn and use 1.0 billion bushels from storage
Crude Oil Imports
6.0 million barrels/day
Set - Aside
Acres
(24.7%)
Use 4.9 billion bushels
U.S. Oil Imports
1.2 billion bushels
1.7 billion bushels
U.S. Corn Exports
Domestic Food Processing Sector for Corn

Figure 2. Possible relationships using a "sink" rather than exports to dispose of excess supply (example only).

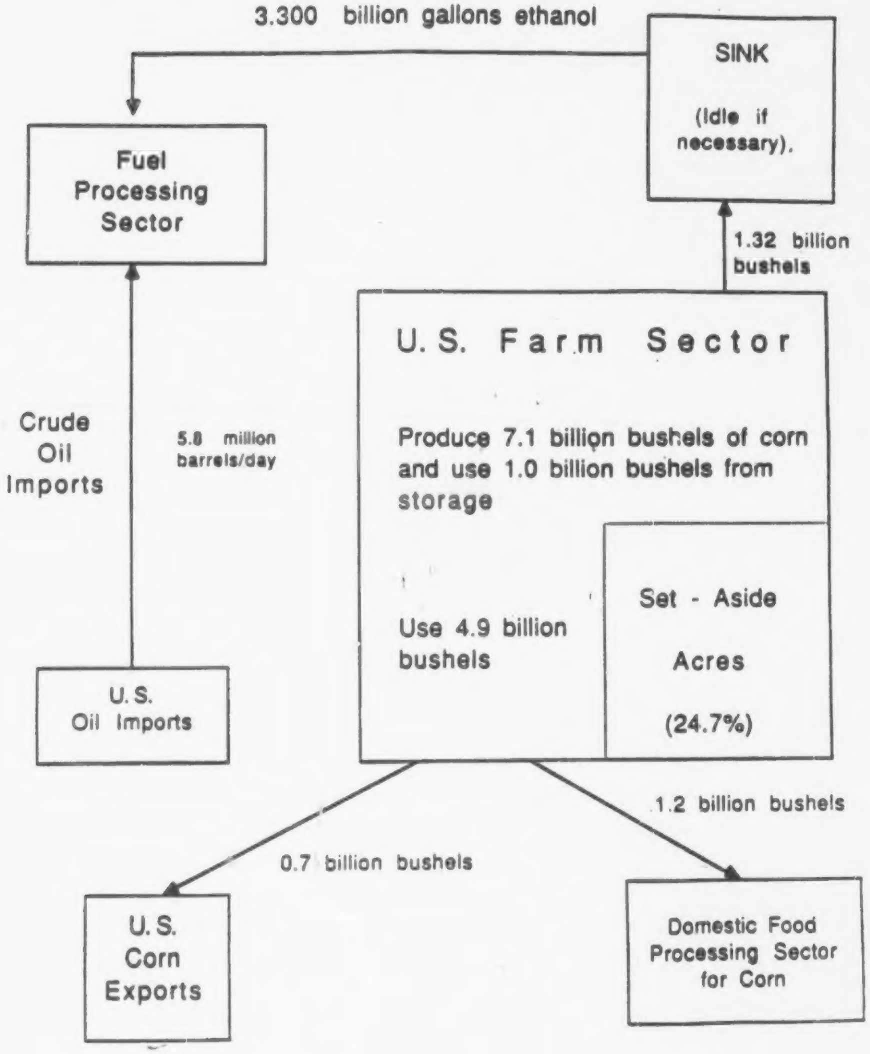
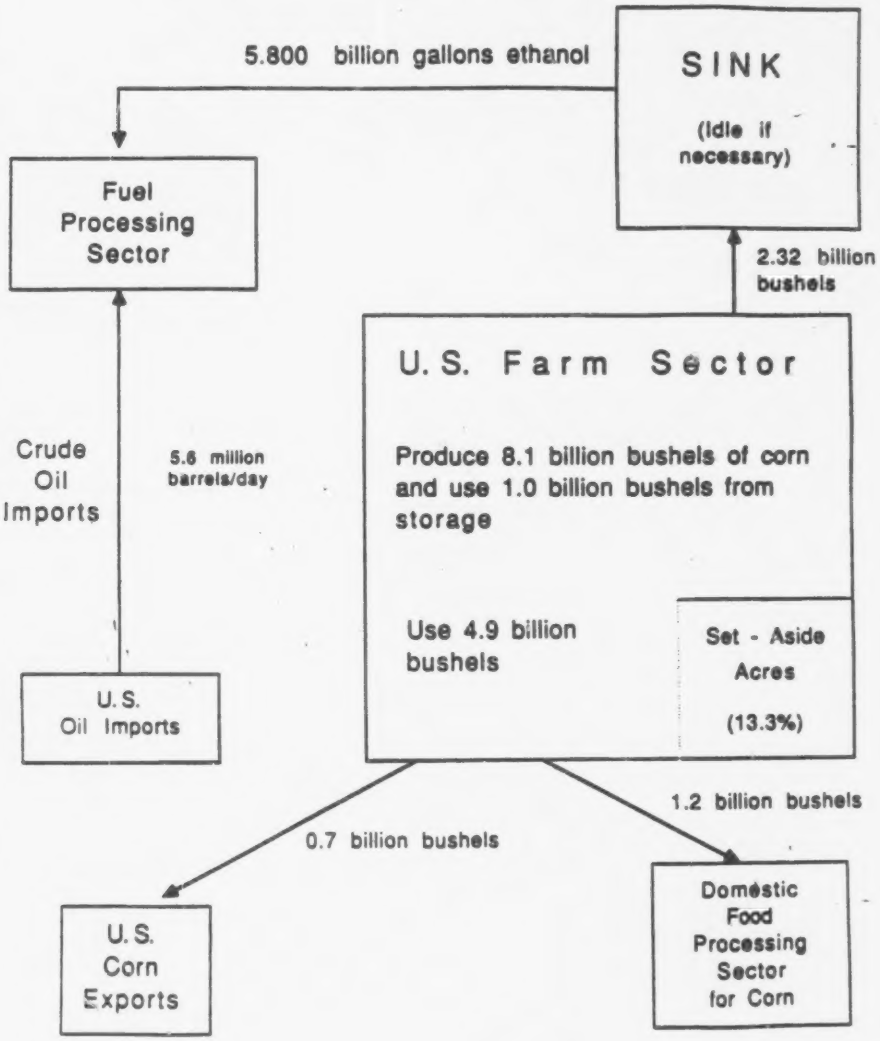

3.300 billion gallons ethanol
SINK
(Idle if necessary).
Fuel Processing Sector
1.32 billion bushels
U. S. Farm Sector
Crude Oil Imports
5.8 million barrels/day
Produce 7.1 billion bushels of corn and use 1.0 billion bushels from storage
Set - Aside
Acres
(24.7%)
Use 4.9 billion bushels
U. S. Oil Imports
1.2 billion bushels
0.7 billion bushels
U. S. Corn Exports
Domestic Food Processing Sector for Corn

Figure 3. Future relationships with a demand enhancement instead of a set-aside policy and then using a "sink" to dispose of excess supply example only).


5.800 billion gallons ethanol
SINK
(Idle if necessary)
Fuel Processing Sector
2.32 billion bushels
U.S. Farm Sector
Produce 8.1 billion bushels of corn and use 1.0 billion bushels from storage
Crude Oil Imports
5.6 million barrels/day
Use 4.9 billion bushels
Set - Aside Acres (13.3%)
U.S. Oil Imports
1.2 billion bushels
0.7 billion bushels
U.S. Corn Exports
Domestic Food Processing Sector for Corn

Senator **Bingaman**. Thank you very much.

Our final witness on this panel is Dr. Richard Klimisch, who is with the General Motors Corporation, and has been an executive director of General Motors Environmental Activity Staff overseeing General Motors activity related to vehicle safety, fuel economy and all aspects on pollution.

We are very pleased to have you here. Thank you for coming.

STATEMENT OF DR. RICHARD L. KLIMISCH, EXECUTIVE DIRECTOR, ENVIRONMENTAL ACTIVITIES STAFF, GENERAL MOTORS CORP.

Dr. **Klimisch**. Thank you.

Good morning, my name is Dr. Richard Klimisch. I welcome this opportunity to share GM's experiences with alternative fuels with you today.

At GM we currently have programs of a wide variety of alternatives, including electric vehicles, fuel cells, solar power—I hope you will recall the Sun Racer—compressed gas, hydrogen. Each has unique characteristics regarding costs, supply, environmental impact, customer acceptance, et cetera. And based on these considerations, as well as the potential for large-scale use, alcohols are receiving the most attention at GM and will be the focus of my remarks today.

Our program on alcohol fuels is broad. We have both dedicated and variable fuel vehicles, but we are focusing on the latter, the variable fuel vehicles, because they provide enormous advantage for the transition of gasoline to alcohol. It is the first step, if you will. Thus GM is supplying 2,220 Chevrolet Corsica and Lumina variable fuel vehicles for the California Energy Commission. That is the largest VFV fleet that we have so far. These vehicles can burn virtually any mixture of gasoline, either methanol or ethanol; 20 have been delivered so far, with 200 next year and the remaining 2,000 in 1992.

A major rationale for this large demonstration program for us is to accelerate the validation of designs for alcohol fuel vehicles. We have developed a proprietary fuel sensor and a variety of fuel modifications for these cars.

Regarding dedicated fuel vehicles, I will just mention the Methanol Marathon, which we had a large part in, as well as the DOE and SAE; and that program we viewed as quite successful. It was for one hundred percent dedicated methanol vehicles.

Demonstration programs cannot do it all, and we are carrying out a number of research programs at our labs, which include projects designed to resolve some of the remaining tough problems. These include false start, material compatibility of lubricants and control of formaldehyde. The latter is really the toughest, and it is the key to whether or not there will be large environmental benefits from methanol in particular.

I should mention also that fuel specifications are important; in particular there is some need for a improved fuel additive chemistry. This represents an important issue that is for a long term emission control durability, which is of crucial importance.

Of course, the ultimate cost of the alcohol fuel is a concern, but that is not something that is our core of business.

Finally, I need to make some remarks about low-concentration-range blends, which has been much of the discussion today; the low concentration blends with gasoline. These are important to cities, like Albuquerque, with carbon monoxide problems, at least in the short run. I think that these plants have been underestimated in terms of their contribution to fuel flexibility and energy security, et cetera; the blending agents, including the tertiary butyl ethers, methanol and ethanol.

As per a recent quote from our chairman, Roger Smith, that GM is recommending in our owners manual for the 1990 auto year for cars and trucks, essentially encourage, the use of oxygenated fuels; that is, properly blended oxygenated fuels. In addition to these blends being used in older cars. Certain blends will be limited. By that we are primarily worried about volatility of these blends, which if not done properly can lead to some problems. For that reason we also believe the customer makes a choice, either pure gasoline or gasoline plus MTBE, in case his or her car has a problem. We are particularly positive about MTBE and ETBE.

If I had time, I would tell you about some of our breakthroughs in diesels. We have had a very large program on diesel buses running on ethanol. There are about 13 of them in various cities in the U.S. right now. We expect that to grow. It is a real tecnological breakthrough.

It is our fond hope that the free market conditions will bring alcohols into use. But in the short run meaningful incentives can play an important role in commercializing these fuels relating to air quality. Although I would point out that the recent presentation by the Motor Vehicle Manufacturers Association recommended some more aggressive programs on methanol, and there are some interesting similarities between that and the Clean Air Fuel Conversion Act that was recently proposed by the senator from New Mexico.

So just to sum up, General Motors intends to remain in the forefront of developing technologies that can utilize alternative fuels, and I will end there.

[The prepared statement of Dr. Klimisch follows:]

Statement of

General Motors Corporation

before the

Senate Subcommittee on Mineral Resources and
Development and Production

Presented by

Dr. Richard L. Klimisch

Executive Director
Environmental Activities Staff

May 25, 1989
Albuquerque, New Mexico

Good morning. I am Dr. Richard Klimisch, Executive Director, Environmental Activities Staff, General Motors Corporation. As a way of introduction, I have personally been involved over the last five years in testifying at many Senate and House hearings, such as this one, on the subject of alternative fuels. We welcome every opportunity to share our corporate efforts, contributions, and achievements, to date, in this area.

Over the years, General Motors has explored the use of many alternative fuels to extend or replace gasoline and diesel fuel. While we recognize that gasoline is still the preferred motor fuel today and most likely will remain so in the foreseeable future, we continue our research and development into several alternative fuels and engine developments in the continuing quest to reduce emissions from motor vehicles in the most cost-effective manner.

Many alternative fuels can be derived from resources other than crude oil. They include hydrocarbons from coal and oil shale, methanol from coal or natural gas, ethanol and methanol from biomass, compressed natural gas, and liquefied petroleum gases. Moreover, alcohols themselves can be used in neat or near neat forms and also as low concentration blends with gasoline. Our experience with liquefied petroleum gas (LPG) and compressed natural gas (CNG) has been far more limited than with alcohol alternative fuels. Each of these alternative fuels has unique characteristics regarding cost, supply, environmental impact, the vehicle technology required, safety, health-related effects, and customer acceptance. Based on these considerations, as well as the potential for large scale use as a national transportation fuel, alcohols have received the most attention, to date, in the alternative-fuels race.

GM has been investigating alcohols, and methanol in particular, for the last 15 years and has initiated a number of field tests with cars and buses since 1983. At General Motors, our vision for methanol is broad and, accordingly, our programs are varied. We are making concerted efforts to develop vehicles capable of using alcohol fuels both in dedicated and variable-fueled vehicle designs. I will describe these efforts in greater detail in the remainder of my statement.

We recognize that vehicle technology developments are a pre-requisite to making the transition to alcohols because no alcohol-fueling infrastructure is currently in place. Therefore, consideration has to be made regarding the potential importance of the variable fueled vehicle (VFV) in the transition from petroleum-based fuels to alcohol fuels. We are devoting considerable effort to make the VFV transparent to the user, and thus provide a transition vehicle that would satisfy all of our customers' expectations.

In this regard, General Motors is supplying 2,220 Chevrolet Corsica and Lumina VFVs for the California Energy Commission Methanol Fuel Flexible Vehicle Demonstration Program. It is the largest yet announced variable-fueled fleet in the U.S. The program is being funded principally by GM with added support from the CEC. It will be administered by that state agency, and we will provide special service training and support for the variable-fueled fleet. The California fleet will be equipped with GM's newly developed variable fuel control system so the cars can burn M85 (a mixture of 85% methanol and 15% unleaded gasoline), as well as various mixtures of gasoline and alcohols, depending on the fuel chosen by the operator. In the just completed first phase, we supplied 20 Chevrolet Corsicas with 2.8-liter V6 engines, modified to burn any mixture of gasoline and M85. These vehicles can also burn comparable mixtures of gasoline and ethanol. In the next phase, 200 Chevrolet Luminas will be provided in 1991 with the remaining 2,000 Luminas in 1992. All of the Luminas will have modified 3.1-liter V6 engines.

One of the reasons for our support of and participation in this major demonstration program is to accelerate the validation of designs for alcohol-fueled vehicles. We have essentially redesigned the entire fuel system of the vehicles that will be delivered in this program. In addition to the GM proprietary fuel composition sensor, fuel system modifications now include material changes such as stainless steel fuel tanks, teflon lined fuel hoses, and other upgraded plastic and polymeric components in the fuel system. There have also been some improvements in the metallurgy of several engine components. To the extent that use of such premium materials proves necessary for production vehicles, it will obviously impact on the cost of alcohol-fueled vehicles which could ultimately affect market acceptability of VFV technology as well as market demand for these vehicles.

Regarding dedicated alcohol vehicles, GM's most recent program, the Methanol Marathon, was completed this month. GM cosponsored the 1989 SAE Methanol Marathon to explore, under real-world conditions, the advantages and challenges of methanol as an alternative fuel. In November 1988, GM presented each of 15 student engineering teams with a 1988 Chevrolet Corsica LT and a conversion kit to help the students in converting the vehicles to operate on M85. Beyond the required hardware, we also supplied the teams with continuing engineering support throughout the entire nine-month development phase. After converting the Corsicas to methanol use, the 15 teams competed in a five-day, 1,100-mile road rally from Detroit to Washington, D.C. Additionally, dedicated vehicle use of ethanol fuels in Brazil has provided valuable experience in areas such as material compatibility and engine calibration.

General Motors has also been participating in a demonstration program with the Department of Energy and Argonne National Laboratories. In 1986, we delivered five Chevrolet S-10 trucks which operate on 85 percent methanol fuel, with a gasoline cold start system, and five gasoline-fueled trucks for purposes of comparison and analysis. These vehicles have undergone three trouble-free winters in this program.

General Motors is studying the use of alcohols in a variety of powerplants as well. These include two- and four-stroke spark ignition and compression ignition engines, direct-injection stratified-charge engines as well as gas turbines. In fact, our current programs include futuristic technologies such as fuel cells which offer even greater potential for high efficiency and low emissions. Methanol is truly unique in being adaptable to such a wide variety of technology options.

General Motors light-duty alcohol program with dedicated and variable-fueled vehicles continues to focus on solving tough engineering problems such as cold start, driving range, material compatibility, lubricant formulation, and control of formaldehyde emissions. Our scientists are working on developing catalysts for methanol-fueled vehicles which focus on control of formaldehyde emissions. There are also unresolved questions regarding the extent of the potential air quality benefits of methanol. Moreover, fuel specifications, in particular the yet-to-be-developed fuel additive chemistry, are an open issue that must be resolved especially in view of the impact on long-term emission control durability. Although many engineering refinements are still necessary to commercialize the use of methanol, we continue to believe that if the cost of the fuel can be competitive with gasoline, there is a real possibility that methanol will be a viable alternative for the transportation sector in this country.

Finally, with regard to low concentration blends involving gasoline and materials that contain oxygen, such as methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE), methanol and ethanol, we are recommending in our owners' manuals the use of properly-blended, so-called oxygenated fuels, beginning with 1990-model cars and trucks. These blending components can be used without modification to existing vehicles, both in older, open loop and in later closed loop fuel metering system designs within certain blending concentration limits. MTBE and ETBE can be used year-round, and unlike the alcohols, do not pose some of the low temperature miscibility concerns associated with alcohols. These special fuel blends can act to make the engine's air-to-fuel ratio leaner, and result in less carbon monoxide emissions while not increasing the fuel volatility which would benefit evaporative, refueling and running loss emissions.

Turning briefly to heavy-duty diesel engines and bus applications, the development approach required is quite different. The variable-fuel concept cannot be used since alcohol and diesel fuel are not miscible. GM's Detroit Diesel Allison Division — now the Detroit Diesel Corporation (DDC) jointly owned by GM and Roger Penske — initiated a program to provide methanol-fueled transit buses. Currently, four compression-ignition buses fueled by methanol are operating in California and three in Florida. Six additional methanol buses have been provided to New York City. The Canadian government bought four methanol-modified engines from DDC to retrofit transit buses in Alberta and Manitoba. Eventually, about 80 buses in total will be operational by the year 1992. Over the past few years, substantial improvements in the performance of methanol buses have been made, particularly their cold starting and fuel economy, and in emission control.

We would hope that free market conditions bring alcohols into use, because we believe that in the long term this is the only way that alcohols can succeed as transportation fuels. But in the short term, meaningful incentives can play a role in commercializing alternative fuels. The Alternative Motor Fuels Act of 1988 is modest progress toward the development of an alternative fuel market. GM supported this legislation.

Moreover, General Motors has suggested a number of ways to foster development of alcohol-fueled vehicles while easing the burden on the manufacturers. We have proposed reducing the regulatory obstacles, presented by certification requirements for alcohol vehicles, during the introductory years of production vehicles. We have previously discussed reductions in the rigor of the emissions control system durability demonstration, and have also proposed de minimis levels of sales before triggering stringent new requirements, including those for formaldehyde. We believe these steps could have been taken with minimal environmental impact. That is why we were particularly discouraged when in February of this year, the EPA issued the exhaust and evaporative emission standards for methanol-fueled vehicles for the 1990 model year that are almost identical to the rules for gasoline and diesel fueled vehicles. Subsequently too, the California Air Resources Board adopted similar requirements while adding a separate formaldehyde standard for methanol-fueled vehicles.

Presently, GM and the other domestic auto manufacturers are recommending the establishment of an additional alternative fuels pilot program in order to evaluate whether the nation should commit resources to convert part of the motor vehicle fleet to alternative fuels. Today, alternative fuels are not widely available and alternative-fueled vehicles need further development and in-use experience. The pilot program should: include broad-based participation by governments, vehicle manufacturers, energy companies and consumers; be focused in other nonattainment areas besides Los Angeles; and, provide a minimum of two- to three-years' experience in order to collect information regarding technical, market acceptance, fuel availability and economic questions. Additionally, the pilot program should be accompanied by joint industry/government research to resolve scientific uncertainties with regard to anticipated air quality benefits, health effects, and the impact of such fuels on global warming. Until those uncertainties are resolved, we believe that an alternative-fuels mandate would be premature.

There is an obvious need for coordination between the policymakers and the industries impacted, so that available resources can be focused properly. Public policymakers must recognize that requirements for manufacturers to produce a broad range of vehicle types in a short timeframe are very demanding of our resources, with much potential for inefficiencies and redundancies.

Regardless of what alternative fuels may be required by future events, General Motors intends to remain at the forefront in developing technologies that can utilize alternative fuels, including methanol, and we would hope to make our activities a part of any overall coordinated effort you may develop.

I would be pleased to answer any questions you may have.

Senator **Bingaman**. Thank you very much.

I would like to ask Mr. Lindahl, and then perhaps Mr. Lorang, to just comment. From some of the earlier witnesses, particularly Bob Luna and his Technical Assistance Group that has been looking into this and studying some of the reports, my impression is that they do not really think that we have very definitive studies as yet demonstrating the extent of the benefits that we obtain from some of these alternative fuels relating to air quality. Obviously there are some other benefits, and some of those have been cited here by the Department of Energy.

Am I right that there is still a lot to be learned about the extent to which these alternative fuels help us deal with the pollution issue that we have been discussing this morning? If we still have a lot to learn, why has it taken us so long to get this research done?

Mr. **Lindahl**. Well, Senator, a number of studies have been done. I would say there is a large amount of data currently in existence on this subject, and Phil can probably talk more about it. I do not think it is a subject that you can ever know too much about. We are still learning about additional advantages that these fuels have to offer. My feeling is that they can do a lot more than has been generally supposed, particularly neat alcohol, like neat methanol and neat ethanol.

There is a lot to be done with improving the efficiency or use in particular. As you may well have heard, it is commonly assumed that the fuel and economy on neat methanol is often considerably less than it is on gasoline. I think a lot of that has to do with the fact the engines that these fuels are being used in are basically gasoline engines that have been converted to neat methanol. And as technology improves to take advantage of the characteristics of the neat alcohols, like methanol, should be possible to get fuel economies that are considerably greater.

As far as reducing the particular problems that we are concerned with here, carbon monoxide and ozone, all the studies that I have seen strongly support the contention that these would be major improvements in dealing with those problems. And, if anything, the gains may have been understated.

Senator **Bingaman**. Before I ask Mr. Lorang for his views, you cited about $80 million of research that has been done in this general area for the last several years.

Am I right that that research has not focused on the issue of pollution reduction? It has focused rather on the other aspects of fuel efficiency and economics, and those kinds of things?

Mr. **Lindahl**. We do have an environmental office that is concerned with these factors. The primary focus of the work done at the Department of Energy has been more in the area of production and use, and EPA, of course, had the lead with respect to the pollution effects.

Senator **Bingaman**. So you have to depend on EPA to advise you or prepare the studies on the way these alternative fuels help with pollution.

Mr. **Lindahl**. To a very large extent, and in part data that has been generated by other groups.

Senator BINGAMAN. Mr. Lorang, what is your view as to whether you have done the research that needs to be done, or whether we are slowing to get this research done?

Mr. LORANG. I think anyone who is involved in the policy process knows that there are sharp disagreements about what to do for alternative fuels, and I think anybody involved in any policy process also knows that there is always some technical uncertainty.

But the disagreement about policy are differences of legitimate opinion about technical facts. I think in the case of fuels, there really can be no legitimate disagreements within a significant range on whether oxygenated fuels help carbon monoxide. I believe my number, which I said was like 21 percent for the program being considered in Albuquerque, that is a sharp difference from 5 percent of the Technical Assistance Group. I think that just outlines the bulk of the data. There is some data which you can average out and get a 5-percent effect, but it is not the bulk of the data. It is not the most representative data.

Certainly the neat fuel, the non-petroleum fuel, I think it is very clear that there can be a very large ozone benefit for it. The uncertainties are more in what it might take to get that in terms of the cost of control hardware on the vehicles. Again, I do not think it is one that makes a difference between proceeding or not proceeding.

There is, I think, quite a legitimate technical uncertainty disagreement about the ozone benefit of oxygenated fuels. It depends an awful lot on exactly what else is in there besides the oxygen. So the policy program addressed what the oil companies would do with the rest of the fuel.

Senator BINGAMAN. One of the recommendations of this Technical Assistance Group that prepared this report for us was that we do a demonstration project or have a demonstration project done to really determine more definitively the value of oxygenated fuels to reduce carbon monoxide emissions at this altitude. I would just be interested in your reaction, Mr. Lorang, to that as to whether that seems like a needed thing, needed research study, and then I would like Mr. Lindahl's reaction.

Mr. LORANG. I think that it would be hard to surpass what has already been done by the State of Colorado and that would be going on at that same time by the State of Colorado. Therefore, to make a really large contribution to the state of knowledge of high altitude oxygenated fuel benefits. In particular there is a problem that if you did implement a program, you cannot divide Albuquerque down the middle and run one side with oxygenated fuels and one without. Anyone familiar with air quality behavior for carbon monoxide knows that from year to year the values go up and down quite a bit. Certainly something like 5 percent with the 20 percent number that we are talking about. That is a natural variation from one year to the next.

It is just not possible to run a definitive test that could convince everybody. The best test programs are the ones that take one vehicle at a time; test it on gasoline, then on oxygenated with a laboratory that captures that vehicle's emissions. It is the kind that Colorado uses, and the kind we use to collect ours. A program such as that is very useful. A program that lets everything mixed together in the air, and then try to figure out what happened, is inherently very difficult and will not contribute a lot to the state of knowledge.

In fairness to the program, I am not familiar with their program or the details of what they propose.

Senator **BINGAMAN**. Mr. Lindahl, do you have a point of view on this?

Mr. **LINDAHL**. I would agree with Phil's comments. I think we are really going past the point where more demonstration work is needed to be done on low-level plans. They have been used for such a long time now, and in such a large number of vehicles, I do not think there can be any real debate about the benefits that they offer in terms of reducing the air pollution of the type that we have been discussing. Certainly a lot of work has been done in Denver, and in Midwestern States ethanol blends have been used more than 10 years now with good effects, no operating problems.

Tests have been done on individual vehicles and on large fleets to measure the improvement and emissions on those individual vehicles, and the results are usually very consistent. I am not convinced that further testing of that type is going to really add much to the body of knowledge. I think things are moving well past that.

Senator **BINGAMAN**. I would ask, Mr. Lorang, would you be willing to take the proposal that has been prepared and review it and give us your reaction in writing as to whether that is an appropriate course to pursue?

Mr. **LORANG**. Certainly. It did not appear to me in the handouts, so if someone will give me a copy, I will be happy to look at it and send you comment.

I would like to add one other point. I think it will be important in an oxygenated fuels program to keep track of what happens. There is a fair possibility that 10 years from now when the very latest vehicles have penetrated the fleet, one could conclude it is not necessary or not worth the cost. That needs to be kept on top of, starting fairly soon and continuing it for five or 10 years.

Senator **BINGAMAN**. Let me just announce that Dick Wilson who is the director if the Office of Mobile Sources there at EPA has agreed to come out here on the 26 of January to meet with the Clean Air Working Group and the advisory group, Technical Advisory Group, that is working on this to discuss some of these issues.

Mr. **LORANG**. I was going to say he is pretty busy and it is pretty good to get a commitment that far ahead.

Senator **BINGAMAN**. Let me ask about the time delays that were discussed in the previous panel. Do we have a real problem in the way we do these studies at EPA?

Dr. Spengler's testimony was somewhat disturbing in that it seems like we have a 5-year review process to determine what the some of the basic standards ought to be.

Is this something that is inherent in the process? It is a concern that Pete and I will be long gone before we ever find out the answers to most of the questions that are being raised this morning the way things are going. Any of you have thoughts on this?

Mr. Lorang, do you have a point of view? Can EPA speed this up? Should we mandate that you speed it up?

Mr. **LORANG**. I have to beg off for the most part, because I do not work in that part. I really cannot speak for that. That is a different operation. I can assure you that at the technical level and scientific level there is absolutely no bad faith. I do not think there is at the policy level either. Some of the decisions that will be made are enormous in terms of their economic consequences, and there is a natural desire to understand things as well as possible. As well, we are dealing with a contentious issue. It does not speed things up to tangle them up in litigation.

Senator BINGAMAN. Yes, Dr. Klimisch.

Dr. KLIMISCH. When you talk about health standards, some of that, the way the Clean Air Act is structured, there should be possibilities to streamline that process through legislation I would think.

Senator BINGAMAN. Mr. Holmberg, did you have a point of view on this?

Mr. HOLMBERG. Not on this particular point, but I would like to go back to your issue of whether a study here in Albuquerque is a good idea. My reaction is it is a good idea. I am a consultant to the City of Chicago. We are going to be doing a modeling study on the comparative emissions from various types of gasoline, and I think combining that with what could happen here in Albuquerque would be a good idea. Also combining that with the existing data.

One of the things I think we have to look at is not only what we put in the gasoline like oxygenates, but what we take out, like aromatic hydrocarbons, et cetera. It could well be a bigger problem than we really understand at this state of the game. I think we need to get to the bottom of that problem.

Senator BINGAMAN. Let me defer to Senator Domenici to ask questions.

Senator DOMENICI. Thank you very much, Mr. Chairman.

I hope I do not have very many, because we are doing well on time; and I think we might for once finish on time.

Let me ask all of you; from the good doctor from Harvard, one of his five points was because volatile components of fuel can contribute to the formation of irritating aldehydes, acids, mutogenic, and carcinogenic compounds, the current and future composition of gasoline must be carefully evaluated. He was pretty firm on that.

Just generally, not specifically, is that concerning any of the research that is going on at this point in our quest to get away from crude-oil-based gasoline?

Dr. KLIMISCH. I would just respond that the aldehyde is the key one with the respect to alcohol fuels. One of the difficulties in estimating what is going to happen in the atmosphere involves forecasting technology in terms of how well can we get that formaldehyde down in the exhaust. We do not want to move to a situation that is worse. There is a lot of concern about formaldehyde, both as an ozone formation species, and also as a carcinogen. So we do not want to go to something where the cure is worse than the disease. And that really is the key on the technological issue in this alcohol fuel debate.

Senator DOMENICI. Is it a significant enough concern to currently be inhibiting—let us just take your company—General Motors moving ahead more rapidly?

Dr. KLIMISCH. Absolutely not.

Senator DOMENICI. Any other comments?

Mr. **Lindahl**. Formaldehydes are an unburned hydrocarbon, and their formation tends to be somewhat greater with alcohol because of the greater difficulty of getting alcohols into a burnable stage. I think technologies are rapidly coming along that will help facilitate that. So I see it more as a technology transfer problem. This will succumb to technology that has not been utilized to date, but may well be during the next decade.

Also I would like to point out that catalytic converters do an effective job of taking care of formaldehydes as has been shown numerous times. I might also just add, too, in the Brazilian experience where they physically went to a neat ethanol program for all new cars, or mostly all new cars after 1981, and required all existing cars older than 1981 model year to run on 22 percent ethanol blends, even without catalytic converters, they saw a substantial reduction in ozone and smog even during the period when they had rapid population increase. Admittedly, formaldehyde levels were not measured, but the improvement in smog and ozone was measurable due to other environmental results that fuel change brought about.

Senator **Domenici**. I do not necessarily want an analysis of aldehydes or carbon monoxide compounds. All I am interested in here is two things: Are we moving ahead with the research in that field, number one; and at the same time is this an inhibitor to alternative fuel usage?

I gather from the latter, it is not at this point. We are moving full speed ahead because of a crisis of growing oil dependence presumably, and with enough confidence that the alternative is at least no worse than what we are doing in terms of the exhaust.

Is that a fair assessment at this point?

Mr. **Holmberg**. Yes, sir. Senator, I would also like to make a point that in terms of aldehydes, formaldehydes are only associated with methanol, and other aldehydes that are a lesser cause are associated with combustion. In answer to your second question, yes.

Senator **Domenici**. Let me ask all of you this: Assume that last statement of mine is right; that this country is in a terrible mess when our dependence on foreign crude oil is going up dramatically and our use of fuel oil in transportation is going up dramatically, well over 60 percent of all crude oil we use is turned into gasoline or diesel and is used in our mobility. If that is the case, what is the single most important thing you think we should do to move rapidly toward alternative fuel? I know this is an environmmetal clean air hearing, but we have already established that it would not be any worse thing and in some instances ameliorate the air crisis.

Assume that; General Motors, what would you do? What is the most important thing we can do to get into this area?

Dr. **Klimisch**. There is a problem with the customer. We have to make sure the customer wants these cars and we have to make sure the fuel is going to be available. That is where the variable fuel vehicle comes in and makes for an easy transition, because those vehicles can use gasoline. And I think the aggressive programs that AVMA suggested last week are important and the bills like the one that Senator Bingaman recently proposed should be helpful as well.

We are concerned about mandates. That worries us a little bit that we cast the direction now when we really have not had the results of any of these large-scale studies. So to say we are going to do this within five years is pretty scary.

Senator DOMENICI. Let me just follow up on that. There is the Alternative Fuels Act administered by the Secretary of Transportation under which, for instance, he is going to begin to use natural gas in a small portion of the bus fleet in Los Angeles.

I am staying with you. A program like that, directed at a company like yours and the other automobile dealers, could it be important if that secretary was dynamic and interested in fleet operations and alternative.

Dr. KLIMISCH. Yes. I would just add one of the problems that devils us, at the same time the CAFE problem, the Corporate Average Fuel Economy. That was addressed in a bill, and I have forgotten the name of it. That was helpful, but at the same time our resources are limited in terms of the clean air tailpipe reductions, that aspect, the CAFE pressure that is on; and at the same time we are trying to satisfy the customer. At this point with gasoline prices very low, the CAFE represents a horrible threat to the domestic manufacturers because of their traditional focus on larger cars. So our resources are spread quite thin at this point.

Senator DOMENICI. I do not want to take a lot of time. Would you all just give me one specific thing to do to have this happen more rapidly?

Mr. LORANG. Given the extensive attention, which would include short of putting variable vehicles in the hands of many people, unfortunately the next step would seem to be a fairly dramatic one; and that would be one of two things; make methanol fuel attractive to people who buy flexible fuel vehicles. That involves sometimes ecnomoic process and control and such a position raises eyebrows. Or to actually mandate it into production and sales more vehicles that can run on alternative fuels. Short of that, I think we have taken the steps that can be taken.

Senator DOMENICI. Mr. Holmberg.

Mr. HOLMBERG. Focus on the blended fuel, get the good stuff in, oxygen, get the bad stuff out, high vapor pressures, aromatic hydrocarbons, olefin, parafin. Just get the bad stuff out of the gasoline and put the good stuff in.

Mr. LINDAHL. I think it is clear that while we are going through this transition phase it probably is necessary to provide incentives, clearly as the ethanol industry required that in its embryonic days. How long it would be necessary to continue that is open to question. I would hope during the next decade the cost of production could be lowered sufficiently so that would no longer be necessary. Certainly the work that we have been doing would indicate that that is a goal that is achievable.

Cost of methanol is already low. I think it could be brought down even lower. At the same time we have already seen incentives on the use side. CAFE situation is certainly part of that. In California we are seeing a situation where the difficulties that are generated by not using alcohol fuels are so severe that that constitutes a strong incentive on its own.

I think it is important to realize this really is not so much a matter of choice as generally supposed. If anyone thinks we can continue going along the way we have with our abuse of fossil fuels without environmental improvement, I would suggest they visit Mexico City for a few days, particularly in midwinter. There is a city that probably has the world's worst air quality. It has 22 million and sits at an altitude higher than Albuquerque. They are adding the equivalent of Denver to their population each year. They have no catalytic converters. They have lead in the gasoline. It is about as bad a situation as you can get. They are looking at alcohol fuels, alcohol derivatives, because this is the only way they can effect a change over that broad vehicle population in short enough period of time to see some tangible benefits coming from it.

So incentives, whether they are part of the mandates, which the Bush Administration generally is opposed to, or whether it takes the form of applying research to make this a more attractive option on its economic and environmental merits is open to question. But there are a lot of things to be done. That is the sort of thing that this Alternative Fuels Commission will be looking into. Also there is a big advantage in that it will be able to transcend some of the split jurisdiction of this subject that it has had in the past, because of the various environmental agencies have had different perspectives on this problem. I think this is a way to find a bridge over those gaps and bring those viewpoints together and pinpoint one consensus.

Senator **Domenici**. Thank you very much.

Senator **Bingaman**. I want to thank this entire panel, and we appreciate your coming and testifying very much.

We have one additional panel. I would ask them to come forward at this point—Bill Garcia, Ron Sheck, Nadyne Bicknell and Ray Peterson.

We will start with William Garcia, who is the Director of Public Affairs Department, U.S. West Communications here in Albuquerque.

Bill, we are very pleased to have you here. Thank you for coming. We appreciate your willingness to testify.

STATEMENT OF WILLIAM E. GARCIA, DIRECTOR, PUBLIC AFFAIRS DEPARTMENT, U.S. WEST COMMUNICATIONS

Mr. **Garcia**. Good morning, Senator Bingaman and Senator Domenici. My name is Bill Garcia and I am the Director of Public Affairs for U.S. West Communications Company in New Mexico. Thank you for inviting U.S. West to participate in these hearings today.

As you know, U.S. West is one of the seven regional companies that was formed with the divestiture of AT&T. We provide telecommunications over a region that extends from Minnesota to the State of Washington and Oregon and from Montana to New Mexico. So as a corporate citizen in the West we have a very definite vested interest in preserving and enhancing the assets of our serving area.

I am here today to register my company's support for the energy committee's efforts to address the significant and perplexing air quality problem which continues to persist today. I would like to talk specifically about the actions which U.S. West as a corporate citizen has taken and indicate to you that they go beyond compliance with the existing laws and ordinances. In some instances we have taken internal initiatives, which though not very popular, were taken to insure public health and quality of life standards; two aspects important to economic development in Western states.

In New Mexico and throughout our service region U.S. West recognizes that there is an interdependence of economic development and quality of life. These two elements should not be considered separately. Along with jobs and a healthy economy, New Mexicans want air that is safe to breathe and air quality which does not detract from our uniquely beautiful setting.

Let me tell you what U.S. West has done to enhance air quality in Albuquerque and New Mexico.

First, we have worked closely with city officials and local governmental officials in supporting their efforts to promote clean air.

Second, in addition, we have established a subsidy support program to encourage our employees to utilize the mass transit in Albuquerque. That is the Suntran bus system.

Third, implemented a no smoking policy in all of our company's buildings 2 years ago in New Mexico, and today throughout the U.S. West company.

Finally, we are utilizing alternative fuels as a means of reducing automotive pollution.

With regard to supporting the city's efforts, we testified before the city council in Albuquerque on a number of occasions supporting the need for policies which would foster a more healthful environment. Now that we do, indeed, have an ordinance, we worked closely with Judy Espinosa, the director of the City of Albuquerque's vehicle pollution and management department, in setting up and establishing procedures to test our fleet of over 300 vehicles which are headquartered in Albuquerque. I would mention that we not only test vehicles in accordance with the ordinance specifications where we are headquartered here in Albuquerque, but those from outlying areas that come in from Belen, Los Lunas, Edgewood, et cetera, because we believe this is a geographic as well as jurisdictional problem.

I would like to tell you that to date we have tested over 150 vehicles, which is over half of our fleet. We are experiencing about 85 percent success rate, which means that there are about 15 percent of our vehicles which need one kind of adjustment or another. I am pleased to note that we have 2 years in which to meet the standards, and we should be completed by the end of this year, which means we will have beaten the timetable by one full year.

In the latter part of 1988 U.S. West was approached by the city and asked to support an effort to encourage ridership of Suntran buses. And this was a program developed in order to reduce the number of private automobiles on the road by encouraging ridership. U.S. West agreed to support the program by subsidizing our employees' bus fees. Employees basically purchase a pass at one half. The company then reimburses the additional half to Suntran directly. This program started in January of 1989, and so far we have 92 employees who utilize this on a monthly basis. Stated differently, this means that on a daily basis, there are 92 fewer automobiles on the freeways leading to the downtown area.

The third element of U.S. West clean air policies involves a decision to ban smoking. And I will just tell you that this policy was controversial at the time. However, it was upheld as the policy throughout the 14-State U.S. West area.

I want to talk, finally, about the use of alternative fuels. With a fleet of our size we have taken the initiative to test and use oxygenated fuels, such as ethanol and MTBE in three of our metropolitan fleets. Albuquerque was one where we have done that. I will tell you that we basically utilized ethanol E–2000 in our Albuquerque fleet. The results to date have been relatively good. I say "relatively good," because one of the factors that we evaluate is automotive maintenance. If utilization of oxygenated fuels results in higher maintenance costs and shortened useful life of the automobile, then that cost factor will have to be balanced against the benefit derived. We have not had the program in effect long enough to determine cost factors. However early results indicate a favorable situation in New Mexico.

We have supported the use of alternative fuels legislation in a number of our U.S. West States.

Mr. Chairman, Senator, I am at the end of my time frame here, but I do want to tell you that this is the perspective of corporate citizen in New Mexico. I hope the information has been useful, and at the appropriate time I will be happy to respond to your questions.

[The prepared statement of Mr. Garcia follows:]

TESTIMONY OF WILLIAM E. GARCIA
DIRECTOR - PUBLIC AFFAIRS - U S WEST COMMUNICATIONS
BEFORE THE SENATE ENERGY COMMITTEE
SUBCOMMITTEE ON
MINERAL RESOURCES DEVELOPMENT AND PRODUCTION
ALBUQUERQUE, NEW MEXICO
MAY 25, 1989

Good morning, Senator Bingaman and Senator Domenici. My name is Bill Garcia and I am the Director of Public Affairs for the U S WEST Communications Company in New Mexico. Thank you for inviting U S WEST to participate in this panel and provide input regarding our views towards a balanced and comprehensive approach to clean air and all that implies.

As you know, U S WEST is one of seven regional companies which was formed with the Divestiture of AT&T. We provide telecommunication services not only in New Mexico but in 13 other western states which encompass the old Mountain Bell, Northwestern Bell and Pacific Northwest Bell territories. Our service area spans from New Mexico to Montana and Minnesota to Washington state. As a corporate citizen in the West, we have a vested interest in preserving and enhancing the assets of our serving area.

I am here today to register my Company's support for the Energy Committee's efforts to address the significant and perplexing air quality problems which persist today, nearly two decades after adoption of the Federal Clean Air Act. My testimony today will focus on the actions which U S WEST has taken in reacting to the threat that high levels of carbon monoxide emmisions have on our quality of

LIFE. THE ACTIONS U S WEST HAS TAKEN GO BEYOND COMPLIANCE WITH EXISTING LAWS AND ORDINANCES. IN SOME INSTANCES, WE HAVE TAKEN INTERNAL INITIATIVES WHICH THOUGH NOT POPULAR, WERE TAKEN TO ENSURE PUBLIC HEALTH AND QUALITY OF LIFE STANDARDS -- TWO ASPECTS IMPORTANT TO ECONOMIC DEVELOPMENT IN WESTERN STATES.

IN NEW MEXICO AND THROUGHOUT OUR SERVICE REGION, U S WEST RECOGNIZES THE INTERDEPENDENCE OF ECONOMIC DEVELOPMENT AND QUALITY OF LIFE. THESE TWO ELEMENTS SHOULD NOT BE CONSIDERED SEPARATELY. ALONG WITH JOBS AND A HEALTHY ECONOMY, NEW MEXICANS WANT AIR THAT IS SAFE TO BREATHE AND AIR QUALITY WHICH DOESN'T DETRACT FROM OUR UNIQUELY BEAUTIFUL NATURAL SETTING.

LET ME TELL YOU WHAT WE HAVE DONE TO ENHANCE AIR QUALITY IN ALBUQUERQUE AND NEW MEXICO.

- FIRST OF ALL, WE HAVE WORKED CLOSELY WITH CITY OFFICIALS IN PROMOTING CLEAN AIR.
- IN ADDITION, WE HAVE ESTABLISHED A SUBSIDY SUPPORT PROGRAM TO ENCOURAGE OUR EMPLOYEES TO UTILIZE THE CITY'S BUS SYSTEM.
- WE IMPLEMENTED A NO-SMOKING POLICY IN ALL OF OUR COMPANY BUILDINGS.

- FINALLY, WE ARE UTILIZING ALTERNATIVE FUELS AS A MEANS OF REDUCING AUTOMOTIVE POLLUTION.

WITH REGARD TO THE CITY, WE TESTIFIED BEFORE THE ALBUQUERQUE CITY COUNCIL ON A NUMBER OF OCCASIONS SUPPORTING THE NEED FOR POLICIES WHICH WOULD FOSTER A MORE HEALTHFUL ENVIRONMENT. NOW THAT WE HAVE AN ORDINANCE, WE HAVE WORKED CLOSELY WITH JUDY ESPINOSA, THE DIRECTOR OF THE CITY OF ALBUQUERQUE'S VEHICLE POLLUTION AND MANAGEMENT DEPARTMENT IN SETTING UP PROCEDURES TO TEST OUR FLEET OF OVER 300 VEHICLES WHICH ARE HEADQUARTERED IN ALBUQUERQUE. WE NOT ONLY TEST VEHICLES WHICH ARE STATIONED IN ALBUQUERQUE, BUT WE TEST VEHICLES IN THE OUTLYING COMMUNITIES OF BELEN, LOS LUNAS, AND EDGEWOOD.

WE DO THIS BECAUSE WE RECOGNIZE THAT THE AIR POLLUTION PROBLEM IS A GEOGRAPHIC AS WELL AS A JURISDICTIONAL PROBLEM. TO DATE, WE HAVE TESTED ABOUT 150 VEHICLES -- OVER ONE HALF OF OUR FLEET. WE ARE EXPERIENCING AN 85% SUCCESS RATE -- WHICH MEANS THAT 85% OF OUR VEHICLES ARE IN COMPLIANCE. THE REMAINING 15% REQUIRE ADJUSTMENTS OF ONE TYPE OR ANOTHER. WE ARE ESTIMATING THAT TESTING WILL BE COMPLETE BEFORE THE END OF THE YEAR. I'M PLEASED TO NOTE THAT THIS BEATS THE FLEET TESTING TIME FRAME BY MORE THAN ONE YEAR.

In the latter part of 1988, U S WEST was approached by the City and asked to support an effort to encourage ridership of the Sun-Tran Bus system the City's public transportation system. This program was developed in order to reduce the number of private automobiles on the road by encouraging use of the Sun-Tran routes. U S WEST agreed to support the program by subsidizing employee's bus fees. It's my understanding that we are one of three Albuquerque employers participating in this program. Employees purchase a monthly pass of $19.00 for $9.50. The Company pays Sun-Tran the additional $9.50 directly, thus incenting the employee to utilize the bus and increasing the bus's passengers. This program started in January of 1989, and so far we have 92 employees who are utilizing the benefit on a monthly basis. Stated differently, this means that on a daily basis there are 92 fewer automobiles on the freeways and roadway arterials leading to the downtown business area. We believe that as more employees utilize the bus, the more flexible the bus schedules become, thus encouraging a complementary cycle in which all participants win.

The third element of U S WEST's clean air policies involves a decision which was made in New Mexico in 1987. In the fourth quarter of that year the New Mexico State

MANAGEMENT COUNCIL ADOPTED A POLICY -- AT THE URGING OF OUR COMPANY PHYSICIAN -- DR. ROD CABANILLA WHICH BANNED SMOKING IN ANY OF THE COMPANY'S BUILDINGS. THIS POLICY WAS CONTROVERSIAL AND AS YOU CAN IMAGINE, NOT ACCEPTED WELL IN ALL QUARTERS. HOWEVER, THE FACTS WERE INCONTROVERTIBLE AND THE BAN WAS UPHELD. TODAY, THIS IS THE POLICY THROUGHOUT THE U S WEST TERRITORY. THIS POLICY WENT INTO EFFECT COMPANY-WIDE IN JANUARY, 1989. I MIGHT MENTION THAT THE COMPANY OFFERS EMPLOYEE ASSISTANCE THROUGH THE SPONSORSHIP OF SMOKING-CESSATION PROGRAMS AS A MEANS OF HELPING EMPLOYEES KICK THE SMOKING HABIT.

THE FOURTH STEP THAT U S WEST HAS TAKEN IN RESPONSE TO THE AIR POLLUTION THREAT IS THAT OF UTILIZING ALTERNATIVE FUELS. IN NEW MEXICO LAST YEAR, OUR FLEET BURNED SEVEN-HUNDRED THOUSAND GALLONS OF FUEL. REGIONALLY, OUR SIXTEEN THOUSAND CARS AND TRUCKS BURNED FIFTEEN MILLION GALLONS OF FUEL LAST YEAR. WITH A FLEET THAT SIZE, IT'S IN THE PUBLIC INTEREST FOR US TO EXPLORE ANY REASONABLE MEASURE THAT WOULD RESULT IN THE REDUCTION OF TAILPIPE EMISSIONS. THAT'S WHY WE TOOK THE INITIATIVE TO TEST AND INTRODUCE OXYGENATED FUELS, SUCH AS ETHANOL AND M-T-B-E, IN THREE OF OUR METROPOLITAN FLEETS -- ALBUQUERQUE WAS ONE OF THE AREAS IN WHICH THIS WAS DONE. WE ARE CURRENTLY USING E-2000 ETHANOL IN ALBUQUERQUE. RESULTS TO DATE HAVE BEEN RELATIVELY GOOD.

I SAY RELATIVELY GOOD BECAUSE ONE OF THE FACTORS WE ARE EVALUATING IS AUTOMOTIVE MAINTENANCE. IF UTILIZATION OF OXYGENATED FUELS RESULTS IN HIGHER MAINTENANCE COSTS AND SHORTENED USEFUL AUTOMOTIVE LIVES, THAT COST FACTOR WILL HAVE TO BE BALANCED AGAINST THE BENEFITS DERIVED (LOWER CARBON MONOXIDE EMISSIONS). WE HAVE NOT HAD THE PROGRAM IN EFFECT LONG ENOUGH TO DETERMINE COST FACTORS. HOWEVER, EARLY RESULTS INDICATE A FAVORABLE SITUATION IN NEW MEXICO.

IN ADDITION TO NEW MEXICO, U S WEST UTILIZES ALTERNATIVE FUELS IN COLORADO, WASHINGTON, NEBRASKA, IOWA, ARIZONA, MINNESOTA AND OREGON. TWO YEARS AGO IN DENVER, U S WEST OFFERED STATE AND LOCAL OFFICIALS THE USE OF OUR FLEET FOR A CONTROLLED TEST OF BOTH ETHANOL AND M-T-B-E. THE TEST INDICATED THAT THE ADDITION OF OXYGENATED FUELS TO GASOLINE COULD REDUCE CARBON MONOXIDE EMISSIONS WITHOUT AFFECTING MOTOR VEHICLE PERFORMANCE. AS A CONSEQUENCE, OXY-FUELS BECAME A REQUIRED ADDITIVE IN GASOLINE SOLD AT DENVER SERVICE STATIONS DURING THE WINTER MONTHS, WHEN TEMPERATURE INVERSIONS ARE MORE FREQUENT. U S WEST HAS ALSO TAKEN A LEADERSHIP ROLE IN THE INTRODUCTION OF OXY-FUELS LAST WINTER IN PHOENIX AND TUCSON, ARIZONA. AS A RESULT OF OUR POSITIVE EXPERIENCE, MY COMPANY HAS SUPPORTED OXY-FUELS LEGISLATION IN THE STATES OF WASHINGTON, OREGON, IOWA AND MINNESOTA.

MR. CHAIRMAN, I WAS ASKED TO IDENTIFY THE POLICIES AND PERSPECTIVES OF U S WEST IN RELATION TO AIR QUALITY. I'M HOPEFUL THAT MY COMPANY'S PERSPECTIVE HAS BEEN USEFUL TO YOU AND YOUR SUB-COMMITTEE AS YOU CONSIDER REAUTHORIZATION OF THE CLEAN AIR ACT. WE IN U S WEST COMMEND YOU AND YOUR SUB-COMMITTEE FOR YOUR EFFORTS AND WISH YOU WELL IN THIS IMPORTANT ENDEAVOR. I WILL BE HAPPY TO RESPOND TO ANY QUESTIONS THAT ANY OF YOU MAY HAVE AT THIS TIME. THANK YOU.

Senator **Bingaman**. Thank you very much, Bill. It is very interesting testimony. It is obvious that your company has done a great deal to try to come to grips with this.

Dr. Ron Sheck is our next witness. He is Director of Transportation Program Division for New Mexico Highway and Transportation Department; Ron has been very active in our Clean Air Working Group and in the Technical Advisory Group.

We are very pleased to have you here.

STATEMENT OF DR. RONALD C. SHECK, DIRECTOR, TRANSPORTATION PROGRAMS DIVISION, NEW MEXICO HIGHWAY AND TRANSPORTATION DEPARTMENT

Dr. **Sheck**. Thank you, Senator Bingaman. I appreciate the invitation to attend, and also the invitation to participate in the Technical Advisory Group.

I would like to take this time, too, to thank you and Senator Domenici both for the support you have given over the years that I have worked in the public transportation and traffic safety areas with federal legislation. Thank you both very much for that.

Transportation is really the key element to the air quality issue in Albuquerque. If you look at the emissions problem alone, 74 percent of the pollution in the air comes from transportation uses. Another 13 percent comes from road dust in both paved and unpaved roads. Those two elements together make up almost 80 percent of our air quality problem. If that is the air quality problem, it seems to me that what we need to do on a strategic, long term, as well as short-term basis is look at improving the impact of transportation on air quality. This is an issue that requires interdisciplinary approach, both in the public and private sector, as well as various government agencies and across various academic disciplines.

I would like to suggest three strategy areas. Some of these strategy areas are short term and easily implementable, and some are longer termed and require significant investments in both dollars and probably in political action as well.

First of these is the reducing of emissions, and we are doing a lot of things to deal with this right now. The movement toward increased fuel efficiency in automobiles and trucks; the movement toward alternative fuels; development of alternative fuels and implementation of programs, such as oxygenated fuels here in Albuquerque, and the importance of our vehicle inspection program which insures compliance with various standards that have been set up. We also are doing things off vehicle to improve the technology of the transportation to reduce emissions. Such things as better signal synchronization to reduce idle time at intersections.

The second thing that we have focused on is the strategy of shifting travel behavior. Recently the city has launched a program, as well as other cities across the nation, "Don't Drive One in Five." That is great if you have an alternate not to be driving one day in five. Quite frankly, alternate options are very limited here in Albuquerque. There a lot of things going on in the ride pool area that have been very successful. We have the Suntran buses. I think that one in particular provides us an opportunity for doing some new and exciting things in the public transit area.

Just to indicate where we are in public transit, let me just give you quickly an overview of transit ridership in some other cities in the Rocky Mountain West. We are carrying about 5 million people annually on Suntran. Two cities with similar population, El Paso and Tucson, are carrying about 10 million. Denver is carrying about 53 million. I think we need to do additional things in that area. I think there are some opportunities for introducing and expanding public transit. Related to that I would encourage that we look at full fundings of public assistance, keeping in mind our air quality issues, the congestion issues and the conservation issues. Lastly, perhaps, the fact that New Mexico is the number one producer of transit bus vehicles in the Nation; and, in fact, our largest manufacturing industry.

The last thing we need to look at is reducing total travel over time. This is the land use, transportation, air quality, economic development interface and interrelationship. This is a real opportunity for cooperative kinds of things that I think we are not doing yet as other communities across the country are. We have separate entities that deal with each one of these issues in our local and regional planning process. We need to look at them altogether. Ultimately what we need to look at is trying to come to grips with the distance and density issues that are related to transportation, air quality and economic development, et cetera. All these things together are the various components that will help us solve the puzzle. I think we could do a great deal if we work together, and I am a firm believer in cooperative action.

My last thought that I would like to leave you with is my dentist has up on his wall a wonderful poster. It is a poster that is a stack of beer cans, and it says, "Life comes in cans, not in can'ts."

[The prepared statement of Dr. Sheck follows:]

TESTIMONY BEFORE THE
SUBCOMMITTEE ON MINERAL RESOURCES DEVELOPMENT
U.S. SENATE ENERGY COMMITTEE

Albuquerque, New Mexico
May 25, 1989

Ronald C. Sheck, Director
Transportation Programs Division
New Mexico State Highway & Transportation Department

I am Ronald C. Sheck, Director of the Transportation Programs Division for the New Mexico State Highway and Transportation Department, where my responsibilities include the state's railroad, public transportation, traffic safety and multimodal surface transportation activities. Before coming to state government six years ago, I spent 17 years in academia, the last 11 at New Mexico State teaching, among other topics, courses in transportation.

The Transportation - Air Quality Link

Transportation and transportation related activities are the largest contributors to air pollution in Albuquerque. The 1986 Estimate of Atmospheric Emissions Inventory by the city's Environmental Health Department identifies 74.12 percent (209,535 tons/year) of total emissions (282,695 tons/year) as being directly attributable to transportation. Another 13.55 percent is dust arising from public roads and streets. Carbon monoxide -- predominantly from gasoline powered motor vehicles -- and particulate matter -- mainly road dust -- are the main culprits and account for 72.35 percent of the total emissions. While carbon monoxide is the dominant pollutant directly produced by transportation activities accounting for 83.33 percent of all transportation emissions. Hydrocarbons and nitrogen oxide are the second and third largest elements of transportation produced emissions. While these two elements account for only 15.32 percent of transportation emissions, they are significant because of their contribution to ozone formation. Albuquerque's ozone levels are expected to rise beyond EPA acceptable criteria in the next two or three years.

The underlying reasons for the dominance of transportation as the major causal factor in the pollution of Albuquerque's atmosphere are rather simple. The very high number of trips, length of trips and the primary mode of transportation all combine to produce the brown cloud of dust and visible and invisible chemical elements that are esthetically unpleasant and harmful to the health of local residents and visitors alike.

Albuquerque is typical of the low density, spread out cities of the Sunbelt which have experienced rapid growth since the end of World War II. Population has increased from 244,501 in 1950 to 331,767 in the 1980 census and

3

estimated at 379,600 in 1987. The technology and affordability of automobile transportation have allowed people to live at considerable distance from their workplaces. Where the family of the 1940's lived, worked, shopped, socialized and became educated within a clustered neighborhood or local setting, the family of the late 1980's may travel daily to disparate locations throughout the metropolitan area to earn a living and to acquire desired goods and services. Geographic dispersion of residence and other activities has resulted in more travel and longer trips.

Today the motor vehicle is the overwhelmingly dominant means of transportation in the Albuquerque metropolitan area, a pattern that has been typical over the past three decades in the new or rapidly growing Sunbelt cities from California to Florida, although new trends in transportation show shifts taking place in cities all across the country. While the automobile has given us tremendous mobility and been the single most important tool in the changing morphology of our cities in the past few decades, the combustion of gasoline in its power plant releases carbon monoxide, hydrocarbons and nitrous oxides into the atmosphere. Most automobile trips are also single occupant trips, in part because of the nature of travel to specific desired destinations that are scattered but also in part because of perceptions and preferences for going where and when one desires rather than changing personal behavior to travel with others.

In summary, the principal underlying transportation factors which contribute to air pollution in metropolitan Albuquerque are:

1. Increased travel (both the number of trips and the length of these trips) which result from urban growth and the changing locations of residences, work places, retail, service, educational and recreational activities.

2. The dominance of single occupancy automobiles as the travel mode for most person trips. Each vehicle exhaust emissions and stirs up road dust into the atmosphere.

Improving the Impact of Transportation on Air Quality

Given that transportation is the major source of air pollution in Albuquerque it logically becomes the major target for improving air quality. A number of strategies are available for short and long term changes that will lead to cleaner air and clearer skies. Some of the strategies involve reduction of emissions from the polluting vehicles; others involve reduction in automobile vehicle trips through shifts in travel behavior; still other strategies are aimed at reducing total travel while maintaining mobility. No single strategy alone will do the job. Each is a component of a total effort. And that total effort requires coordination and cooperation of individuals and initiatives of the public and private sectors of various levels of government and of technology and human behavior.

Vehicle Emisisons

Reduction in vehicle emissions is one of the approaches currently being undertaken by the City of Albuquerque and Bernalillo County. The mandatory vehicle pollution inspection program reinstituted in a new form this past spring will insure that manufacturer installed pollution control equipment on passenger cars, vans and pickups will function at optimal levels and that vehicle engines will be maintained to reduce exhaust gasses as much as possible. Local governments have introduced a mandatory winter months oxygenated fuels program. Alternate fuel substitutes for straight gasoline, which include blending of methanol or ethanol with gasoline to form oxygenated fuels, produce significantly lower levels of carbon monoxide and hydrocarbons. Consideration should be given to extending the local winter months oxygenated fuels program to a year round basis. This would provide a better test of the impact of oxygenated fuels. Albuquerque also offers the opportunity to test such fuels in the unique atmospheric conditions of a high altitude environment. Information learned here could be most relevant for other high altitude cities in the Rocky Mountain/Intermountain Basin region (Denver, Salt Lake City, Boise, Reno) or even abroad as in Latin America (Mexico City, Bogota, Quito, La Paz) or in East Africa or Asia.

Shifting Travel Behavior

The reduction in single occupant vehicle trips is another strategy for improving air quality. If the number of vehicles on roads and streets can be cut down it logically follows that the volume of emissions released into the atmosphere will fall. However, most people traveling perceive the trips they are making to be "essential". There is little likelihood that appeals to reduce personal trips to improve community air quality will have any significant following. Therefore, we must look at ways of making those necessary trips in a manner that is less polluting.

Albuquerque has recently developed a "Don't Drive One in Five" program to encourage motorists to find alternative transportation one day a week. Such programs have been very successful in other cities where well developed public transportation and car pool programs exist. To encourage peole to get out of their cars without offering them an alternative means of getting around is unrealistic. Albuquerque offers few options.

The community Ridepool program does have an active campaign aimed at getting travelers to share trips in car pools or van pools. About 200 new "match ups" are made every month by this transportation information and referral service. SECA (The State Employees Commuter Association) and New Mexico Commuters Association carry about 350 daily commuters in a pooled van service between Albuquerque and Santa Fe. Public transit service in Albuquerque, municipally owned Sun Tran, carries about 18,000 weekday riders on a route structure that has been little modified since the late 1970's. Some comparative figures of public transit use (1986) in Western U.S. cities are as follows:

1986 Public Transportation Ridership*

Albuquerque	4,914,500
Las Vegas	6,565,500

El Paso	9,594,300
Tucson	10,552,000
Salt Lake City	17,022,600
Phoenix	17,280,000
Denver	53,547,000

*Source: UMTA Section 15 Reporting Data

There is an opportunity for expanding and improving public transportation services in Albuquerque. Expanded transit service could offer an alternative mode for many trips now made by automobiles.

Diversion of travel to public transport can lead to a reduction in automobile emissions -- if public transportation is available and user convenient. Transit service has not kept up with growth in Albuquerque. Bus routes do not extend into suburban areas and evening and weekend service is limited. Transit has become an important element in reducing congestion and improving air quality in the nation's cities. Aggressive programs to expand public transportation have recently been implemented in many Sunbelt cities. El Paso, where voters approved a dedicated tax for transit in late 1987, experienced a 15 percent increase in bus ridership in 1988. Phoenix experienced a 22 percent increase the same year.

Three California cities (San Diego, Sacramento and San Jose) have recently introduced light rail systems which have become the backbone of urban transit services. Both light rail and heavy rail systems are under construction in Los Angeles. Electrically propelled rail systems contribute in a positive manner to air quality maintenance by reducing the number of automobile trips. The 1985 feasibility study of the proposed Albuquerque-Santa Fe rapid rail system indicated that a reduction of 35-50 million annual vehicle miles would result if the rail project were implemented.

President Bush's Transportation Secretary Samuel Skinner recently commented, "The innovations of mass transit will be a part of the strategic national transportation policy currently being drafted by the U.S. Department of Transportation. We will draw heavily on the obvious strengths of mass transit: cleaner air, less congestion and the saving of energy resources as we chart the U.S. transportation future to the year 2020."

Albuquerque, because it has lagged behind other cities in public transportation development, has an opening for moving ahead in new directions by drawing upon the best and most innovative elements in transit from other communities across the country and around the world.

Elements worthy of consideration by Albuquerque include:

1) High Occupancy Vehicle (HOV) for transit buses and van pool and other shared ride vehicles (a study is underway).
2) Employer sponsored subscription bus services to major work locations.
3) Additional express bus services from suburban park-and-ride locations.
4) Transit centers in downtown, uptown and suburban locations allowing convenient transfer between routes.
5) Employer subsidized monthly pass programs.
6) Constant evaluation of the route structure and service levels to keep abreast of changing population distribution and travel needs.
7) Education and marketing programs aimed at attracting new riders to the system. Implementing a transportation information system.
8) Consideration of fixed guideway transit as a future option for heavily traveled paths and for such options to tie in with the proposed Rio Grande Corridor Rapid Rail project.

9) Development of a regional approach to public transportation planning and operations. Phoenix, Salt Lake City and Denver all have multi-county regional transit authorities.

On the technology side, Sun Tran has shown considerable initiative in pursuing options to reduce transit vehicle emissions by moving to test CNG (compressed natural gas) in five new buses and retrofitting five existing vehicles for similar use. This is part of a $35 million UMTA initiative to encourage less polluting alternate fuels in public transit vehicles.

While some may argue that Albuquerque residents will not forego their automobiles for transit, the evidence from other rapid growth low density cities in the west is to the contrary. More people ride the bus every day (1.7 million) in Los Angeles, the automobile and freeway capital of the world.

Reducing Total Travel

The growth of travel is taking place at a faster rate than the growth of population in the Albuquerque metropolitan area. Data gathered by the Middle Rio Grande Council of Governments show that annual VMT (vehicle miles travelled) has grown from 29 percent between 1980 and 1988. During the same period population increased by 14 percent.

The relationship between transportation and land use is well recognized. The type of use and the density of use (residents, employees per unit area) are both major factors. Southwestern cities like Albuquerque have low densities, particularly showing a residential proclivity for single family dwellings on large lots which results in a sprawling urban configuration with long distances to travel between home and work place. A sprawling low density population results in geographically large trade areas for goods and services meaning that trips that two or three generations ago that were made by walking to the corner grocer or drugstore today require getting in the car. Dispersed residential patterns and scattered employment, retail and service locations mean longer travel.

A greater emphasis in the planning process needs to be put on transportation impacts. Sprawling growth and leapfrog development produce increased travel because of the greater lengths of individual trips. The dispersed nature of origins and destinations of these trips often works against shared ride vehicles and public transportation. The result is ultimately deteriorating air quality because of the growing VMT of polluting vehicles.

Planning activities and development strategies need to be reevaluated in terms of potential transportation impact. Higher density occupancy of land results in increased potential for public transportation options. Increased use of public transportation results in lower demands for parking space, can curtail the need to expand street capacity and relieve traffic congestion.

Our experience teaches us that transportation facilities help shape communities. Transportation influences development patterns and profoundly impacts suburban sprawl and downtown development. Public transit, fixed guideway systems in particular, strengthens development in existing built up areas to take advantage of the investments already made in public utilities and buildings.

We need to be more cognizant of the transportation land use relationship as we plan for future growth in the Albuquerque region.

In the 1970's, the U.S. Environmental Protection Agency and the U.S. Department of Transportation required metropolitan planning organizations to develop transportation plans consistent with clean air goals. Unfortunately, last fall the U.S. DOT began to back away from those requirements. I find it disturbing given the potential impact of transportation on attaining air quality, that we are weakening this crucial link in the overall planning process.

The connections between transportation, land use and air quality deserve far more attention than we are giving them. In Albuquerque, as in many other urban areas, the planning responsibility for these three elements lies with different agencies. I strongly suggest that close coordination and cooperation are essential and perhaps there needs to be a single body that has review and oversight functions.

Importance of the Interdisciplinary Approach to Air Quality

Improving air quality is a complex task. No one of the strategies outlined above will solve the air pollution problems of Albuquerque. But each contributes toward the overall goal of improving the quality of our local air. The technology strategies reducing emissions can be implemented in a short time frame and requires limited public expenditure. The public transit strategy necessitates public investment that can range from a few million to tens of millions, but also produces mobility, land use and development benefits that are long term. The coordination of transportation land use and air quality planning and program implementation will produce the most lasting community benefits, but requires long and often politically difficult action.

Senator BINGAMAN. Thank you for that excellent testimony. We will have some questions as we get to the other two witnesses here.

Our next witness is Nadyne Bicknell, who is a member of the Albuquerque City Council here in Albuquerque. Nadyne and the other members of the Council have really taken a leadership role in seeing to it that this issue has been properly addressed or is being properly addressed here. She has been and continues to be an active and effective advocate on behalf of Clean Air. We are very pleased to have her as a witness.

STATEMENT OF NADYNE C. BICKNELL, MEMBER, ALBUQUERQUE CITY COUNCIL

Ms. BICKNELL. Thank you, Senator Bingaman and Senator Domenici. It is a pleasure to be here today. My purpose in testifying is to give you a quick overview of the strategies that Albuquerque is pursuing to combat air pollution.

I would like to heartedly endorse what Ron Sheck has told you. I agree right down the line, and I think that he has struck the same theme that I wanted to, and that is the cooperation needed, the interrelatedness of all strategies. There are so many strategies and various levels of government which are involved in strategies to combat air pollution.

You have before you a rather elaborate sheaf of papers constituting my testimony, and the topic is so broad that I just want to touch on a number of the strategies that Albuquerque is pursuing. You can read about them in detail in the sheaf.

You have already heard about our alternative fuels programs that has been testified to quite a bit. Woodburning program, which was instituted this year and has been quite successful in dealing with carbon monoxide problems from fireplaces, as well as cars that we have been talking about.

We are concerned now about land use consideration. We have been concerned about land use considerations and air pollution control, but we are stepping up efforts to evaluate through our environmental health department the effect that land use has on air quality problems. The interrelatedness of the transportation that new land use projects bring, density problems, impact on congestion, and air quality there. The air quality control board and the department is now planning to promulgate some procedures and legislation to aid in the evaluation of air quality.

You have heard about our vehicle inspection program. The emphasis right now is our carbon monoxide. The hydrocarbon level is set very high in the current program, but by January 1, 1990, the failure rate for both carbon monoxide will step up from about 10 to 20 percent here in the Albuquerque region. And the hydrocarbon levels will be set low enough so that we will be able to catch vehicles which are emitting too many hydrocarbons.

As you know, we are not over exceeding these levels on hydrocarbons, but we are getting near, perhaps. This has been a better winter, but we are trying to get ahead and arrange a number of strategies as to avoid exceeding the acceptable levels rather than trying to deal with the problem after it already occurs.

We have a no-smoking policy or a stringent indoor smoking policy that you all have heard about. There are additional policies in place.

Our transporation strategies, many of them, have a direct impact. As Ron says, maybe 80 percent of the carbon monoxide comes from transportation-related sources. We have a long range transportation plan. We have many transportation strategies, signalization, computerized signals have been mentioned, limited access highways. We have a recently completed study which went to the ultimate capacity of the interstate system.

Again, a point about the relationship between federal and local policies, the State and Federal highway administrations have told us that our interstate is reaching capacity. That will affect air quality because of the lower miles per hour the vehicles can travel on the interstate. They would not allow us to put a new airport interchange or any other interchanges on the freeway until we ascertained what the capacity was going to be, and what we were going to be able to do to relieve the interstate through alternate arterial programs. So we have done that, and by the way the cost over the next 20 years of doing all the recommended improvement approaches, $1 billion, which says a lot of things. One of which, the fiscal constraints are going to be such that that may alone give a real push to the idea of alternative transportation means, because even if current funding sources remain in place, we can only look at $250 million of that $1 billion; and how we come up with the other set of a hundred or so million is a real quandry.

Our transportation department is doing a number of things in the clean air campaign. Their alternate fuel initiatives were to install natural gas engines on standardized buses and purchasing six natural gas-powered minibuses. They are looking at employer commuter subsidy program. We have two major studies going on in the uptown area.

We are so sprawled out now in Albuquerque, as you know, that we have had great difficulty getting to our goals in transit. We will continue having those difficulties. We are concentrating on the uptown area. Again, a combined problem of new growth, proper access to the freeway and improved transit capability in uptown. We have had a couple of very similar general and private grants to look at the project in uptown. That project will take a great deal of coordination.

I am sure we share the frustration here that you must on the federal level of having all the agencies of government trying to work together to forward legislative goals. That has been a problem that the National League of Cities has seen, as well as we locally; conflicts between Federal agencies as well as our local agencies.

Difficulites with EPA trying to impose sanctions at the same time that the Federal Highway Administration is trying to build roads. The conflict between trying to reduce vehicle miles traveled and the Highway Trust Fund allocation formulas which reward states which have higher vehicle miles traveled. That is a real conflict that that needs to be addressed. I will tell you, sometimes we are treated like a stepchild of the Highway Trust Fund.

Because of the clean air implications as well as all the other mobility needs to be strongly addressed when the Surface Transportation Act at the federal level is reauthorized, this is a frustration of the National League of Cities. There is no coherent federal transportation policy, which attempts to fit together what is to be expected of all the different modes of transportation. That needs to be federally addressed. Those federal policies have a tremendous affect on what we can do locally. We try to plan together our transportation strategies on a regional level, again the federal money coming down has a great deal to do with our flexibility to do that local planning.

My time is up. I am sorry. This is such a broad topic that I would have enjoyed talking to you a great deal longer.

Senator BINGAMAN. Go ahead, if you have any additional comments. I think you are giving us very useful information.

Ms. BICKNELL. In the stack of material I gave you is a fairly complete transportation and clean air positions of the National League of Cities, and in there they point out some of those issues and the need of recognition at all levels of government the strong influence transportation planning has on land use and clean area issues and the need to interrelate all of those problems.

At the end of this is a letter from the chairman of the National League of Cities energy and environment committee to one of the members of the senate, talking about the conflict I just mentioned about the attempts to reduce the vehicle miles traveled and the rewarding. Also the subsidy of alternative fuels. I hate to say this because there are a lot of people in the audience in here, and I am very interested in alternative fuels, but they are exempt from the fuel tax, and that reduces the income in the Highway Trust Fund. And I just mention our $1 billion of transportation needs locally. Multiply that by all of the states and cities nationally, and the Highway Trust Fund is inadequate to fund the transportation needs.

NLC is not saying that either one of these is a bad thing, the exemption of ethanol and methanol from fuel tax. But that again the policy needs to be knit together and something needs to be done federally to recognize these conflicts that occur.

[The prepared statement of Ms. Bicknell follows:]

Testimony before U.S. Senate Subcommittee on Mineral Resources Development and Production of Energy and Natural Resources Committee

Nadyne C. Bicknell, Albuquerque City Council
May 25, 1989

Senator Bingaman and distinguished members of the committee:

My purpose in testifying today is to present some strategies Albuquerque is pursuing and planning in its continuing battle not only to prevent the further deterioration but hopefully to improve the quality of our air. I will further touch on our interactions with other levels of government and the air quality and transportation position and questions raised by the National League of Cities.

The City of Albuquerque has various departments and agencies responsible directly or indirectly for various strategies against air pollution. Coordination of these efforts is essential and a continuing challenge. Here are programs which are underway and planned:

Enclosed in your printed copies of my testimony are National League of Cities policies on clean air and transportation. I will highlight a few of these.........

There is also a recent letter from the chairman of NLC's Energy, Environment, and Natural Resources Committee to Senator Joseph Lieberman. It addresses some conflicts in Federal policy which need to be addressed.........

We see other instances of Federal agencies working at cross purposes, such as EPA attempts to impose sanctions sometimes resisted by the Federal Highway Administration in their efforts to complete road-building projects.

Thank you for the opportunity to testify before you today. I will be happy to answer questions.

Woodburning Program

Albuquerque's "no-burn" program was the first to address the issue of woodburning derived carbon monoxide (CO) (one-third of our winter CO). This was also the first program in the country to rely totally upon meteorological criteria in the declaration of "no-burn" periods. Other programs rely upon "action levels" of a pollutant to declare a "no-burn." Albuquerque's method of using meteorological conditions allowed the city to act in a preventive mode instead of reacting to already high levels of a pollutant.

The program resulted in less woodburning in Bernalillo County. As a result, fewer emissions of the toxic and priority pollutants, 14 different carcinogens, co-carcinogens, cilia toxic substances, mucus coagulating agents and other respiratory irritants known to exist in woodsmoke were released into our skies. The public noticed the difference. The reduction in violations of the federal standard for CO (4 in 1988, 19 in 1987) exhibited by Bernalillo County this year reflects the program's effectiveness.

The data regarding the "no-burn" program were derived from only 11 "no-burn" periods but, it appears the "no-burn" program reduced the peaks of CO levels. When maximum values of CO on days when burning was allowed and "no-burn" periods are compared, it appears that the "no-burn" periods prevented the levels of CO from reaching the higher levels that would be expected during the evenings and early mornings. This late evening and early morning CO are largely caused by woodburning. The "no-burn" program may have lowered CO levels by 10-20% on evenings when relief was needed urgently.

The Albuquerque/Bernalillo County Air Quality Control Board passed a regulation on August 17, 1988, which will prohibit the sale of new wood heaters after July 1, 1989 that are not emission certified by the EPA. Adoption of this regulation assures the installation of less polluting wood heaters in Bernalillo County.

In order to slow the proliferation of wood heaters that are uncontrolled for atmospheric emissions, a group was formed to look at the issue of wood heater installation. This group consists of realtors, home builders, woodburning unit dealers, code enforcement officials and environmental health professionals. Recommendations to limit the number of woodburning device installations and initiate an installation permitting process have been developed.

Alternative Fuels

Over two-thirds of the CO in Albuquerque's winter ambient air is derived from motor vehicles. An alternative fuels bill directed the Albuquerque administration to examine methods of utilizing alternative fuels (electricity, compressed natural gas, oxygenated fuels or others) in city vehicles. The second part of the bill asked all citizens of Albuquerque to use oxygenated fuels, increase their usage of mass transit and carpooling and to decrease the number of miles they normally drive. The third part of the bill asked the Albuquerque/Bernalillo County Air Quality Control Board to begin developing regulations for a mandatory oxygenated fuels program in Bernalillo County for the winter of 1989-1990. A later bill recommended criteria for the mandatory oxygenated fuels program. Depending on program design, an oxygenated fuels program may reduce CO by 10-20%.

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LAND USE CONSIDERATIONS AS AN AIR QUALITY STRATEGY

Attainment and maintenance of National Ambient Air Quality Standards (NAAQS) is strongly influenced by area-wide and site specific land use and transportation decisions. Land use patterns and their consequent traffic generation exert a strong influence on the type and amount of air pollution occurring in an area. For this reason, it is important to estimate the magnitude of impact that can result from certain land use and transportation decisions and incorporate this information into final project or plan design.

The Air Pollution Control Division has actively participated in the City planning process since 1985 by reviewing and evaluating the impacts of major projects and plans on ambient air quality. Staff within the Air Pollution Control Division (APCD) review all requests for development plans, subdivisions, zone map amendments, sector plans and neighborhood plans. When appropriate, computer modeling is applied to quantify impact and evaluate the benefit of various mitigation strategies. The APCD also actively participates in the development of Area, Sector, Corridor and Transportation Plans by serving as technical support for other City and County agencies.

Currently, the APCD is promulgating legislation and procedures to aid in the systematic evaluation of air quality impact of projects and plans. It is envisioned that this legislation will allow air quality to be incorporated as a key consideration in major land use decisions. The procedures anticipated will serve to establish threshold levels for project review and outline methodology and assumptions for quantitative analyses.

MOTOR VEHICLE INSPECTION PROGRAM

This plan amends the carbon monoxide nonattainment provisions of the State of New Mexico SIP as it pertains to Bernalillo County. It establishes a new vehicle inspection maintenance program to effect attainment of standards by the end of 1991. The most recent ambient air data show a design value of 14.6 ppm, 8 hour average, second highest value occurred in 1984. This ambient value suggests the need for a 40% reduction in emissions of CO. The emissions inventory for the 1984 baseline year was 216,211 tons/year. The I/M program, in concern with the federal motor vehicle control program improvements, is expected to produce a net reduction of 88,292 tons/year so that the 40% reduction goal will be met with a margin of 1842 tons. The I/M program by itself will reduce carbon monoxide 46,000 tons/year and will account for 20% of the carbon monoxide reduction goal by the end of 1991. The I/M program committed in this plan will be decentralized with computer type analyzers, checking 1975 and newer light and heavy duty vehicles for tail pipe emissions, antitampering, and lead contamination of the exhaust system, to commence March 1, 1989, enforced by a tie to the state motor vehicle registration process.

The inspection Maintenance Program is underway with present failure rate for carbon monoxide set rather leniently at 10%. On January 1, 1990, the CO failure rate will increase to 20%

Albuquerque has not exceeded EPA allowable levels for hydrocarbons although we occasionally approach this limit. The hydrocarbon level for the current I/M program is set high and will catch only extreme cases. On 1/1/90 more stringent hydrocarbon regulations will be instituted. Data will be collected over a one to two year program on hydrocarbon reduction by this strategy. If the I/M program alone will not prevent exceedance of EPA regulations on hydrocarbons, a vapor recovery system will be implemented.

ADDITIONAL RESEARCH ON AIR QUALITY

The Air Pollution Control Division, as well as other individuals of technical background, know that additional research and testing must be done to further the understanding of Albuquerque's air quality problems.

Areas in which research is needed are:

- What is the composition of the visible clouds that can be seen during the spring, summer and early fall
- What is the public health risk posed by residential wood burning and by diesel vehicular emissions
- How do the surrounding counties affect Albuquerque's air quality and how does Albuquerque's air pollution affect them

In addition, enclosed is a rough draft of the Technical Advisory Group's report for the Clean Air Week Summit. This rough draft contains a discussion of Albuquerque's air quality problems and possible solutions.

Sandia National Laboratories conducted the Winter Visibility Study in the winter of 1983 for the City of Albuquerque and has done a carbon monoxide source apportionment study in Albuquerque funded by the State.

Currently, there are no active proposal for additional research. It is hoped that the Clean Air Week Summit will focus attention on additional research needs and a funding source to perform such research might be identified.

SW/cp 05/19/89
cc: File
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Sun Tran

CITY OF ALBUQUERQUE
TRANSIT/PARKING DEPARTMENT
INTEROFFICE MEMORANDUM

MAY 22 1989

May 22, 1989 Ref. NO.: 0519891.mem

TO: Councillor Nadyne Bicknell, City Councillor

FROM: Vern Barela, Director, Transit & Parking Department VB

SUBJECT: CONTRIBUTIONS TO CLEAN AIR EFFORTS

Per your request for information on Sun Tran contributions to clean air efforts:

Alternative Fuels Initiative - Compressed Natural Gas (CNG)

An Urban Mass Transportation Administration (UMTA) grant application is currently being prepared. Sun Tran will be installing 10 CNG dedicated engines on standard sized buses and will purchase six (6) CNG powered mini-buses. Various locations are being considered for the fast fill fuel site. The differences in operating costs and emissions between the CNG and diesel engines will be evaluated over a three year period. Sun Tran is working with divisions of the Environmental Health Department and the General Services Department. Additionally, two private sector companies and the Natural Resources, Energy, and Minerals Department of the State of New Mexico will be involved. The total amount of the project is estimated at $2.8 million; the City's share is estimated at $530,000.

Clean Air Campaign

Sun Tran, Ridepool and others participated in a Clean Air Campaign in October 1988, through February 1989. Promotional activities were undertaken to make Albuquerque citizens aware of alternatives to single occupancy vehicle travel. A 'Don't Drive One In Five' campaign was implemented as was an employer subsidy program for Sun Tran monthly commuter passes. A 9.4% increase in transit ridership was observed during this time period.

Employee Commuter Pass Subsidy

Several major Downtown employers pay 50% of the $19 price of a Sun Tran monthly bus pass for their employees. Sun Tran's Outreach Program will be approaching other employers in the near future to inform them of this program and to encourage their participation. Under study for City Council is a bus pass subsidization plan for City employees. The recommendation of this study will be made to the Council by August 1, 1989.

Uptown Transit Study

The purpose of this planning project is to identify methods to increase transit ridership in the Uptown area and thereby reduce air pollution and traffic congestion. Based on an Uptown employee travel survey and an onboard destination survey (conducted on Sun Tran routes serving the Uptown area) alternative service plan options were identified. These options will be presented to the City's Agency Review Group, Uptown Transit Study funding participants, and the Uptown Advisory Group. The Uptown Advisory Group is composed of the neighborhood associations in the Uptown area, area businesses and other interested parties. The remaining tasks to be completed are: approval of the final service plan, development of a marketing plan, estimations of operating and capital costs and the final report. This study, which began during fiscal year 1988, will be completed in December 1989.

Uptown Mobility Study

In October 1988, Sun Tran co-hosted with the Middle Rio Grande Council of Governments (MRGCOG) an Uptown Mobility Seminar. This seminar was one of twelve that were held nationwide and looked at new methods of providing non-traditional transit service. As a result of this seminar MRGCOG received an UMTA grant for a long-range planning project to develop solutions to projected traffic congestion problems in Uptown. Sun Tran expects to participate in this study. This project will focus on vehicle demand management.

Long Range Needs Assessment Study

A $320,000 UMTA grant has been received to develop a long-range transit development plan. The study will identify unmet transit service needs, capital infrastructure and fleet expansion needs, develop a park-and-ride program, and study High Occupancy Vehicle (HOV) lanes. A background review is in progress and the Request-For-Proposal is scheduled to be completed by August. The estimated completion date of this study is in December 1991.

Platinum Injectors

In February 1989, Sun Tran fitted six (6) platinum injectors on its bus engines; the initial results were encouraging. In April 1989, 30 additional engines were fitted with the platinum injectors. These injectors are being tested to see if they bring about improvements in bus fuel efficiency and bus opacity. The study will run until September 1989.

VB/BAR/br

cc: John Parker, Manager, Marketing & Planning

POLICY FOR INTERSECTION CAPACITY ANALYSIS AND TRAFFIC IMPACT STUDIES

The following policy combines the elements described in Chapters 1, 2, and 3 of the Final Report into one document which is intended to be considered for adoption by the City of Albuquerque.

DRAFT RESOLUTION

The purpose of this policy is three fold:

1. To satisfy of the City of Albuquerque Council Resolution R-28 Enactment Number 45-1984, which mandates the establishment of intersection capacity analyses by the City staff to improve the City's understanding of the impact of land development and its associated traffic generation on the highway system. Resolution R-28 Enactment Number 45-1984 further mandates that the City staff shall undertake intersection capacity analyses to help the City evaluate the following discretionary City actions:
   - o Zone changes and conditional use requests where the new land use category is likely to generate significantly more peak hour traffic then the existing zoning category.
   - o Major subdivisions.
   - o Sector and neighborhood development plans.
   - o Zoning site development proposals as the Traffic Engineer many conclude deserve intersection capacity analyses because of the projects' importance to traffic flow patterns, whether or not such developments require discretionary City approval.
2. To implement a criteria that objectively, and without bias, establishes the need for traffic impact studies in support of zone change requests, site plans, major subdivision plans, sector and neighborhood development plans, zoning site development proposals, and other development proposals.
3. To implement a procedural guideline to provide for consistent, comprehensive, and meaningful traffic impact analysis studies.

5.01 Transportation

A. Transportation Problems

The United States has built the most complex and extensive transportation system in the world. The benefits of this system cannot be underestimated. However, past governmental policy encouraged the rapid extension of existing highway, aviation and railroad systems without any consideration of the future availability of energy, environmental, or fiscal resources. Nor was the impact of these policies on cities and on the quality of life ever adequately considered. Further, past fiscal and regulatory policies treated different modes in an unequal manner, causing some modes to have a competitive advantage over others. Past policy also focused too heavily on urban and interurban transportation needs while failing to adequately provide transportation services in rural areas and in small cities.

As a result, the damage done by past transportation decisions was extensive. Highways in some cities divided neighborhoods, encouraged the outflow of jobs from city centers, supported the movement of the middle class to the urban fringe, and contributed to sprawl development patterns. Automobiles consumed scarce energy resources and contributed to the degradation of air quality in many cities. Airports in some cities attracted unplanned and harmful urban development and caused intolerable noise pollution. Trucks damaged the highway infrastructure and weakened an already unstable freight rail industry.

During the past few years, there has been increased pressure to expand existing passenger transportation services to meet the needs of the handicapped and disadvantaged and to help conserve needed energy resources. Federal financial support for a floundering rail industry has also become a national priority. At the same time, scarce fiscal resources have limited the ability of government to even maintain the existing infrastructure, much less to expand, improve, or construct needed new services.

B. Transportation Goals

In order to rectify these problems, the nation's transportation program should foster the development of transportation systems which:

1. provide access to jobs, services housing and other opportunities at affordable prices, with reasonable convenience, speed, safety, and efficiency within and between urban areas;
2. provide for the movement of goods safely, conveniently, and efficiently, with economy and speed within and between urban areas;
3. provide mobility for all citizens, and in particular, serve the special mobility needs of the elderly, the handicapped, the young, the poor, and those without automobiles;
4. contribute to the achievement of desired local urban economic and physical development goals;
5. contribute to the preservation and strengthening of regional economies;
6. reduce the contribution of transportation systems to local air pollution;
7. reduce the amount of the nation's petroleum resources consumed by transportation;
8. reduce the contribution of transportation systems to noise pollution and to pollution of the visual environment;
9. promote the preservation and protection of natural and urban resources such as open space, recreational land uses, and neighborhoods; and
10. enhance urban aesthetics by utilizing good environmental design practices.
11. enhance coordination of our intermodal network to stimulate economic growth and strengthen our competitive position in world trade.

C. General Transportation Principles

In the development and implementation of transportation policies and programs, federal, state and local governments should be guided by these general principles.

1. Equity: all transportation users and all areas should be served equitably by planned transportation systems. No single jurisdiction or user should bear the burden of financing transportation service. All modes should be considered in an equal manner so that no single transportation mode has a competitive advantage over another.
2. Cost-effectiveness: transportation service should be provided in the most cost-effective manner possible without compromising the level or quality of that service.
3. Comprehensiveness: a transportation system should provide a full range of services within an urban area, consistent with local transportation needs.

4. Flexibility: transportation systems should be flexible enough to positively respond to changes in national priorities or to changing external circumstances, such as a national embargo on imported oil.

5. Coordination: local transportation systems should complement and be coordinated with local land use, housing and economic development, environmental, energy, and air quality programs. Transportation decisions should not be made which would negate the purposes expressed in other urban programs.

6. Local Preeminence: fundamental responsibility for transportation planning and decision-making should be placed at the local level. Local governments should have the authority and the flexibility to ensure that transportation plans support local objectives and satisfy local needs. Where there are overriding national or statewide transportation concerns, federal and state governments have a legitimate role in planning and decision-making but local governments should never be excluded from those processes.

7. Reliance on the Marketplace: transportation should be considered by all levels of government as an essential public service whose purpose is to serve public needs rather than to generate profits. If the private marketplace can provide transportation services in a manner consistent with the broad social purposes of transportation, then it should be encouraged to do so.

D. Transportation Priorities

The full development of transportation systems is constrained by limited fiscal resources. In response to this constraint, federal, state and local governments should give highest priority to the efficient utilization, management and maintenance of the nation's existing systems of streets, highways, airports, rail, transit, paratransit, bicycle and pedestrian facilities, and waterways. Second priority should be given to the improvement and upgrading of existing systems. Third priority should be given to the development of new transportation systems. None of the above priorities are meant to preclude the utilization of new technology if that technology is cost effective or if that technology provides the same level of service at lower cost.

After the interstate system is completed in 1991, the federal government should redirect the national transportation priorities to the urban and suburban areas of this country.

5.02 Multimodal Transportation Policies

A. National Transportation Policy

At present, there is no definitive statement of national transportation policy which is based on a clear understanding of national urban and rural transportation needs. Current modal policy is frequently inconsistent and has been developed without adequate participation by other federal agencies and state and local governments. To rectify this problem, NLC strongly urges the federal government to develop a comprehensive, intermodal transportation policy, utilizing other existing national transportation studies to the extent possible. The policy should set measurable, attainable goals for the nation's transportation system which could be used to guide the development of future transportation services and the allocation of scarce transportation resources.

The federal government should establish a systematic process for the development and periodic reappraisal of such transportation policy. This process should be designed to ensure participation by relevant federal agencies and state and local officials. The process should also ensure timely input of appropriate data relevant to the development of such a policy. Once developed, the Administration should give continuing, high priority to the conversion of policy into action.

B. Transportation Planning

1. Local Role in Transportation Planning

Federal policy must continue to recognize the need for local elected officials to play a preeminent role in local transportation planning. Federal regulations should continue to require that the principal elected officials of general purpose local governments be adequately represented on the metropolitan planning organization (which is the forum for cooperative, transportation decision-making by local elected officials) and that such officials be able to participate, along with the governor, in the designation and redesignation of the planning organization.

2. Metropolitan Planning Organizations

The federal government should continue to require the Metropolitan Planning Organization (MPO), in cooperation with the state transportation department, publicly owned operators of public transportation agencies, and local implementing agencies, to be responsible for developing the planning work program, the transportation plan, and the transportation improvement program/annual element. The MPO endorsement of these plans and programs should be a prerequisite for approval of federal assisted highway or transit projects in urbanized areas.

3. Project Identification

The federal government should continue to require local elected officials to identify and recommend for implementation proposed transit, federal aid urban system, and certain Interstate substitution projects. These projects should be included in the transportation improvement program and endorsed by the MPO.

The states should continue to be responsible for identifying urban Interstate projects, and urban extensions of the primary system, and certain Interstate substitution projects. The states should be required to include those projects identified in the transportation improvement program in their statewide program or projects. States should be prohibited from recommending for implementation transit, federal aid urban systems or certain Interstate substitution projects unless those projects are first included in the transportation improvement program.

4. *Financing Transportation Planning*

The federal government should continue to provide adequate financial assistance for local highway, airport and public transportation planning efforts. The MPO should be the direct recipient of public transportation, airport and highway planning funds for all urbanized areas.

5. *Certification*

The federal government should allow the state and the MPO to certify that the planning process is being conducted in accordance with federal laws and planning requirements. The Department of Transportation should periodically review the certification to ensure its accuracy.

6. *Transportation Research*

New technologies for solving transportation problems should be encouraged through a continued federal program of research and development. New techniques for operating and managing transportation systems should be a part of the federal research agenda.

Federally financed planning, research, and demonstration efforts should be broadened to include intracity and urban goods movement to augment the economic and urban development and redevelopment of our cities.

7. *Urban Impact Analysis*

The social, environmental, economic, and energy impacts of proposed federal transportation legislation and regulations should be identified prior to implementation, and steps should be taken to mitigate any adverse impacts. Existing federal transportation programs and regulations must be carefully monitored to ensure that no actions are taken which would inadvertently impact cities or negate urban conservation efforts.

C. Transportation Finance and Administration

1. *Federal Transportation Financial Assistance*

A combined program of local, state, and federal transportation assistance is necessary to finance transportation needs of the nation's cities.

Sufficient federal resources must be committed to the development, maintenance and improvement of needed transportation services, particularly public transit services. Congress should reexamine the transportation funding levels authorized under current legislation to determine if the amounts authorized are sufficient to meet America's transportation needs. At the same time, the federal government must increase its efforts to remedy the imbalance in federal subsidies to each of the transportation modes.

Additionally, the federal government should take steps to identify alternative sources of transportation funding and alternative financing mechanisms in order to establish an equitable and realistic funding base for all transportation improvements. New sources of funds, such as federal revenue sharing funds, state sales tax-supported transportation trust funds, increased highway user fees, and new financing mechanisms, such as value capture financing, should be investigated. Legal and institutional barriers to the implementation of these funding sources and financing mechanisms should be identified, and eliminated to the extent possible. However, while there is an obvious and justifiable federal interest in seeing that federal funds are spent wisely and that an overall national transportation policy is being implemented by the expenditures, federal control over the funds should not have the effect of giving the operation of local systems to federal officials.

2. *Transportation and Tax Policy*

Transportation projects are funded directly from federal spending programs and indirectly through tax expenditures allowed under the Internal Revenue Code. Cities rely heavily on the tax-exempt bond market to finance roads and bridges, airport facilities, improvements to docks and wharves, and, to a lesser extent, mass transit facilities. Therefore, the National League of Cities is opposed to any proposal to severely limit the use of tax exempt bonds for transportation and other infrastructure facilities.

Further, NLC supports exemption from taxation for bond proceeds which would be used to finance critical types of infrastructure facilities such as: airports, docks and wharves, roads and bridges, mass transportation commuting facilities, wastewater treatment facilities, drinking water facilities, and solid waste facilities.

NLC opposes the prohibition of advanced refunding, the additional limitations on arbitrage earnings and the elimination of the deduction for interest paid by financial institutions carrying tax exempt bonds. All of these changes would make the use of tax-exempt financing more difficult for cities and would increase short-term borrowing costs.

NLC also opposes the elimination of deductibility for state and local income, sales, property and real property taxes. The loss of deductibility will make it much more difficult to raise local revenues, will put pressure on local governments to reduce spending, will lower bond ratings, and will increase the cost of municipal borrowing at a time when city infrastructure needs are increasing.

Finally, NLC opposes changes to the tax code which would discourage vanpooling, carpooling and transit usage. Current law allows the value of employer-provided commuter services to be excluded from the gross income of employees. NLC opposes the termination of this exclusion.

3. *Administration of Federal Transportation Programs*

Excessive red tape and the resultant delays in applying for and obtaining federal transportation assistance must be eliminated in order to increase local control and make more effective use of limited financial resources.

D. Land Use and Economic Development

Federal, state, and local transportation policy should recognize that transportation can be a significant factor in influencing the direction and type of urban growth and can facilitate orderly metropolitan growth and desired land use patterns. In order to ensure that the impact of transportation on urban development is beneficial, federal transportation policies should explicitly support national urban conservation objectives.

local governments which voluntarily agree not to levy a fee or tax on the transportation of hazardous materials.

Several steps should be also taken to strengthen enforcement of federal railroad safety regulations which effect the rail shipment of hazardous materials. The penalty provisions of the Federal Railroad Safety Act should be increased and should be imposed upon the offending individual and not just upon the railroad company. The Act should also be amended so that it clearly gives the federal and state governments concurrent authority to enforce federal rail safety regulations which relate to hazardous materials.

Additionally, the State Hazardous Material Enforcement Development (SHMED) program, which was created by the federal government to help states establish hazardous materials transportation inspection and enforcement programs, should be retained and adequately funded and broadened to include rail-related enforcement.

Finally, the Federal/State Rail Safety Participation program, which pays half a state rail safety inspector's salary, should be continued and adequately funded.

10. Financing

The federal government should establish a national trust fund based upon a registration fee which will generate enough revenues to pay for state and local hazardous materials-related needs (e.g., emergency response enforcement, planning, training, equipment and personnel). Funds should be distributed to state and local governments based on a formula which takes into account the amount of hazardous materials shipments passing through each jurisdiction annually, and in proportion to the amount of risk that is caused by such shipments, and should include all shipments made by or under the direction of the United States Department of Energy or Defense.

In order to be eligible for funds from the trust fund, a state should demonstrate that: it has initiated a program to develop a statewide emergency response plan, designated a lead agency for administering emergency response activities; agreed to assist local governments in emergency planning and response; agreed to pass a portion of its hazardous materials entitlement to local governments for planning and emergency response purposes; and established an emergency response coordinating council consisting of state, local government and industry representatives.

Any state or locality which chooses to accept funds from the hazardous materials trust fund would be precluded from levying its own fees on the transportation of hazardous materials. A locality which can demonstrate that it has a unique hazardous materials problem or need, which is not being satisfied by its federal trust fund suballocation should, be allowed to levy its own fees on the transportation of hazardous materials.

11. Insurance

The federal government should set minimum insurance requirements for all large quantity or Type B (health hazard) radioactive materials shipments and shipments made by or under the direction of the United States Departments of Energy or Defense, to ensure that shippers are financially able to bear emergency response and cleanup expenses.

12. Federal Administration of Hazardous Materials Programs

Congress should adequately fund the Materials Transportation Bureau and other related hazardous materials offices within DOT so that they can more effectively enforce the Hazardous Materials Transportation Act, more expeditiously process inconsistency petitions and promulgate regulations, more consistently collect and disseminate data and more effectively coordinate federal hazardous materials.

5.03 Modal Policies

A. Public Transportation

1. General

NLC believes that public transportation is an essential public service whose primary objective is to provide mobility for all people, including the disabled, elderly and economically disadvantaged, in all places and not simply for those who can afford to pay for the service. Further, NLC believes that public transportation can contribute to the viability of the nation's cities by helping to reduce congestion, stimulate economic development and create employment opportunities; therefore, its provision is in the national interest. Since public transportation will never be self-supporting, it should continue to be subsidized by a partnership of federal, state and local governments. Concurrently, public transportation authorities, with the assistance and cooperation of transit labor unions, should continue their efforts to reduce operating costs and increase transit revenues.

2. Farebox Policies

Transit authorities should implement fare policies which reflect time-of-day and distance traveled. They should not establish across-the-board fare increases on all users, since such increases do not serve the public interest. However, fare increases alone will not generate enough revenues to satisfy existing and future transit needs, and additional subsidies will continue to be needed.

3. Transit Productivity

Local transit authorities should continue their efforts to improve productivity through better management, increased use of part-time labor, routing maintenance programs and similar strategies. Maintenance and productivity indices should be incorporated into the federal allocation formula and there should be incentives in the matching-ratio to encourage productivity improvements and maintenance of existing transit facilities. However, productivity improvements alone will not mitigate the problems of rising transit costs and inadequate transit revenues.

4. Role of the Private Sector

The private sector should be encouraged to participate in the provision of transit and paratransit service where that service is complimentary to the existing public transportation service and where there can be a partnership of public and private providers. Decisions about the terms and conditions of private sector participation in transit, including the decisions to subcontract with private providers if warranted, should be made at the local level, not the federal level. NLC opposes federally imposed, competitive privatization of transit service because such privatization undermines the public-serving nature of transit and may have deleterious effects on the ridership and revenue base supporting transit. Further, since privately provided transit services will never serve all transit needs, the burden of meeting transit needs should continue to rest on the shoulders of the public transit authority or other public transportation providers. However, while NLC opposes the imposition of new regulatory requirements on local transit system use of private enterprise, we support the provision of new, special funding for privatization demonstration efforts.

5. *State and Local Role in Public Transportation*

State and local governments should increase their support for transit and move toward more stable and reliable sources of funds. In order to encourage greater local participation in transit and to ensure that projects of highest priority are built, formula and discretionary apportionments should be based, in part, on a measure of local financial contribution to transit beyond the statutory requirements, commensurate with local ability to pay.

6. *Federal Role in Public Transportation*

Since the provision of public transportation service is of national interest, and since fare increases, productivity improvements, privatization, and increased non-federal contribution will not generate enough revenues to meet transit needs, the federal financial commitment to transit should, at a minimum, be continued at current levels. NLC strongly opposes proposals which would reduce or eliminate that federal commitment by turning back the transit program to states; merging the program with the federal aid urban systems program, eliminating funding eligibility for new fixed rail starts; or phasing out operating assistance. Without adequate federal funding, the viability of the nation's public transportation systems would be threatened.

7. *Unified Transit Grant*

NLC supports the concept of a unified transit grant which would be created by merging existing transit capital and operating assistance programs for urbanized and nonurbanized areas into one program with a single funding authorization.

The unified grant program should be funded, in part, by revenues generated from increased highway user fees which are earmarked for public transit and placed in the Mass Transit Account of the Highway Trust Fund, and in part from general revenues. Funds in the Mass Transit Account should be used exclusively for transit purposes. These revenues should be used to supplement the general fund portion of the federal transit program. Under no circumstances should they be used as a substitute for those transit funds.

A major portion of the funding (e.g. 75 percent) should be allocated on a formula basis and the remaining share should be granted to recipients on a discretionary basis for capital assistance purposes. Any authorized increases or decreases in federal funding for transit should occur in such a way as to maintain this ratio between the formula and discretionary portions of the program. In other words, any additional funding for transit over currently authorized levels should be allocated in large part on a formula basis, and the remainder should be granted to recipients on a discretionary basis. Any reductions in funding for transit should come primarily from the formula portion of the program with smaller reductions in the discretionary portion.

Further, we strongly recommend that the federal government should impose as few restrictions on the use of the funds as possible and that local recipients should have the flexibility to tailor the federal transit assistance to local capital or operating needs.

We strongly oppose any suggestion that the unified grant program be structured to give state governments primary responsibility for its administration. In particular, we would oppose the inclusion of state governments in the administration of the program for urbanized areas above 200,000 population. We are also opposed to the state administration of the federal transit programs for areas below 200,000 unless the states are required to make funding allocation decisions in consultation with and with the concurrence of, affected local governments. Federal transit assistance must continue to be allocated directly to designated recipients in these areas and the recipients must continue to be responsible for transit planning and development. The restructuring of the federal transit assistance into a state block grant program would impose an unnecessary layer of bureaucracy between federal and local governments and would simply substitute states as the delivery agent without improving the program. In order to encourage greater coordination between all federal public transit assistance programs, the Urban Mass Transportation Administration should be given the responsibility of administering all of these programs, including the transportation assistance program for small urban and rural areas.

8. *Discretionary Funds*

Alternatives analysis, preliminary engineering and construction of new fixed-rail starts, downtown people mover projects, and urban initiative projects should be considered as eligible activities under the discretionary grant set-aside. Any type of capital improvement which is cost-effective and appropriate to local needs and conditions, including new fixed-rail starts, should be eligible for federal transit assistance.

In order to allocate scarce discretionary assistance equitably and to ensure that priority projects are built, the Secretary should establish a process and specific criteria for evaluating proposed major capital investments. The criteria should include, but not be limited to, such factors as: projected ridership population and population density of the area served by the proposed capital investments; cost-effectiveness of the proposal; relationship of the proposal to transit needs; and local financial commitment to the project, commensurate with local ability to pay.

Eligible recipients of discretionary transit funds should have the authority to contract for capital assistance over a multi-year period, so as to facilitate long-term system budgeting, planning and development and to allow accumulation of enough capital to initiate large scale projects. However, the amount that can be obligated to each project per year should be limited in order to avoid the obligation of available capital funds to only one or two eligible projects.

NLC opposes the division of discretionary transit assistance funds into separate categories for new starts, rail rehabilitation and bus improvements and the establishment of minimum funding levels for each category. We believe that this undermines the discretionary nature and flexibility of the program and limits the ability of the program to respond to changes in transit needs.

Further, the League strongly opposes the establishment of a process for approving the apportionment of discretionary funds that is similar to the Interstate Cost Estimate approval process. Under this procedure, Congress would approve the apportionment of discretionary funds only after the DOT has submitted an estimate of the total of amount of discretionary funds needed to fund all eligible projects. We believe that such a process would weaken the flexibility of the discretionary grant program and would make the apportionment of discretionary funds unnecessarily difficult.

In addition, the League strongly opposes any attempts to earmark a minimum percentage of the discretionary transit funds for allocation to the states, since the states already receive a portion of transit formula funds. Nor should there be any guaranteed minimum percentage return to any state of the amounts paid into the Mass Transit Account by that state.

9. *Formula Funds*

The unified transit grant funds, exclusive of the discretionary set-aside, should be allocated on a formula basis using 1980 census data.

We recommend that the federal share for capital assistance projects should continue to be 80 percent. For operating assistance projects, the share should continue to be 50 percent. There should be incentives in the matching-ratio to reward improvements in transit productivity and encourage maintenance of existing capital facilities and rolling stock. A similar approach should be developed to promote rehabilitation of existing fixed-rail systems.

Both operating and capital expenses should be considered as eligible activities under the formula grant program. NLC is strongly committed to the federal operating assistance program. However, we recognize the need to improve and refine the operating assistance program, in order to provide transit operators with an incentive to control costs and improve the productivity of their transit service. Consequently, we recommend that the transit operating assistance should be continued, but the allocation formula should be restructured in the following manner:

a. the largest portion of the unified grant formula funds should be distributed to urbanized areas over 200,000 because they provide the greatest share of transit service and carry the highest proportion of passengers. The bulk of these funds should be allocated to areas with bus systems and the remainder should be allocated to areas with rail systems. However, recipients which do not spend all of their bus entitlements, should be allowed to use those funds for rail development purposes and vice-versa;

b. the funds for these areas should be distributed according to separate bus and rail formulas and should be targeted toward public transportation systems with high levels of service. The bus formula should be based, in part, on population, population density, revenue-vehicle miles of travel (including carpool and vanpool miles of travel), productivity, and nonfederal revenue contribution. The rail formula should also be based on some measure of the level of rail service which rail systems provide, productivity, and nonfederal revenue contributions. Such a dual formula would reduce past inequities between bus and rail systems, would reward local financial commitment to public transportation and would provide incentives to local governments to control costs and improve system productivity;

c. urbanized areas with population between 50,000–200,000 should be allocated a somewhat larger share of formula funds than they received prior to 1982, in recognition of the large number of newly urbanized areas eligible for formula funds. Funds for these areas be distributed according to a formula based on population, population density and transit service, in order to reward smaller cities which are currently providing high levels of transit service;

d. the remainder of the formula funds should be allocated to nonurbanized areas with populations below 50,000. Funds for these areas should continue to be allocated in proportion to the share of nonurbanized population within each state. However, these funds should be reapportioned after a two-year (instead of four-year) period, in order to encourage quicker obligation of available revenues;

e. there should be a ceiling on the level of a transit system's operating costs which can be covered by federal operating assistance so that no jurisdiction receives a disproportionate amount of assistance;

f. in order to give cities maximum flexibility in the use of their formula transit funds, cities which do not spend all of their capital assistance entitlements should be allowed to redirect those funds and utilize them for transit operating expenditures and visa versa. This would prevent unnecessary or unproductive capital and operating expenditures and would allow a better match of operating and capital assistance to local transit

15. Procurement Requirements

The federal government should reexamine its present procurement policies to determine if changes can be made to expedite the production and procurement of transit vehicles. Alternative bidding procedures which are better suited to present transit production conditions should be given due consideration. Additionally, the federal government should replace the present transit design specifications with functional performance standards which give manufacturers latitude in choosing an appropriate technology to meet a specific technical objective.

16. Federal Transit Design Policy

Efforts should be made to increase rider usage of public transportation by enhancing the public image of transit vehicles through the use of aesthetically appealing design.

17. Commute Alternatives

NLC supports locally developed transportation systems management by encouraging and supporting federal legislative action which will generate:

a. development of transportation programs emphasizing increased public transit, ridesharing, bicycling, parking management, and citizen education;

b. creation by large employers and developers of individualized programs to promote trip reduction measures and commute alternatives;

c. incentives to small employers to join together to coordinate and promote ridesharing programs;

d. coordination among communities in development of transportation systems management programs;

e. state and federal tax incentives to increase ridesharing and public transit usage; and

f. incorporation of ridesharing and other high occupancy riderships concepts into drivers' education curriculum.

B. Streets and Highways

1. Highway Finance

NLC strongly supported the increases in gasoline, diesel fuel and other excise taxes, which were enacted in the Surface Transportation Act of 1982. It has become increasingly apparent, however, that the revenues generated by tax increases are those inadequate to meet future highway needs. Therefore, in order to preserve the present federal aid highway program and to keep the Trust Fund solvent, we urge the federal government to increase the user-generated taxes which support the federal highway program.

The requisite revenues could be raised from a number of different sources. First, Congress should require heavier trucks (e.g. at least 33,000 pounds) to increase their contribution to the Highway Trust Fund so that they pay in proportion to the costs they impose on the highway system. The heavy-use truck fee should continue to be required until such time as the Department of Transportation can recommend to Congress an alternative tax which is more equitable than the heavy-use tax, easy to administer, and will generate at least as much revenue as the use tax.

Second, Congress should eliminate the exemption for gasohol and methanol from the federal fuel tax. Although we believe that it is good public policy to encourage the production and use of alternative fuels, we do not believe that such activities should be subsidized by Highway Trust Fund revenues.

Third, Congress should allow the use of toll financing on federal aided highways and bridge projects, as is currently permitted on certain federally aided bridges and tunnels.

Fourth, Congress should develop incentives for local governments to increase their contribution to the federal highway program (e.g. by allowing localities to increase the local matching share of highway funds at their discretion). However, in no way should these increased contributions be considered a substitute for the federal highway funds to which a state or locality is entitled.

Fifth, Congress should enact an overall increase in the existing nine cent fuel taxes, (both diesel and gasoline); the revenues from which should go into the Highway Trust Fund for transportation purposes only. NLC strongly opposes increasing the federal fuel taxes for the purpose of reducing the federal deficit.

The revenues generated by the increased highway-user taxes should be distributed equitably among all highway programs and all urbanized areas should receive an equitable share of the funds. To this end, every state should be guaranteed a minimum return on its contribution to the highway portion of the Highway Trust Fund. Under no circumstances should the additional revenues be allowed to accumulate in the Highway Trust Fund. The artificial ceiling on highway obligations should be lifted and state and local governments should be allowed to spend out available funds.

Highway spending should not be artificially reduced so that Highway Trust Fund revenues will accumulate unspent, thereby helping to lower the federal deficit. To prevent the buildup of balances in the Highway Trust Fund, the Highway Trust Fund should be removed from inclusion in the unified federal budget.

2. Federal Aid Highway Turnback

NLC believes that the federal-aid highway program has enabled this country to build one of the best highway systems in the world and that massive future infrastructure needs necessitate the continuation of this program. NLC strongly opposes proposals to dismantle that program by turning back all or a portion of the federal aid highway program to the states.

3. Interstate

In order to expedite the completion of the Interstate system, while preserving the nation's massive investment in funding. However, state and localities should be permitted to use less than the maximum federal share at their option.

The federal government, upon request, should allow the metropolitan planning organization (MPO) and the local government to implement appropriate design standards for a particular FAUS project when the use of rigid federal design standards is inconsistent with local needs. Additionally, local governments should be certified to make basic design and construction engineering determinations, and to oversee project construction where they have the capacity to do so.

The federal government should allow FAUS funds to be used to decrease adverse impacts on neighborhoods, to reduce noise pollution, and to encourage urban beautification and the improvement of urban environmental design.

10. Highway Beautification

Although NLC supports the concept of highway beautification, we believe that the present, federal Highway Beautification Program has imposed too high a cost on state and local governments and has been limited in its effectiveness. We recommend that the responsibility for controlling outdoor advertising and junkyards should be returned to municipalities and to states in areas outside municipalities. These governments should have the authority to order the removal of those signs and the relocation of those junkyards that are incompatible with state and local land use plans and zoning laws and to allow sign and junkyard owners to amortize their losses through advertising revenues. Federal controls over outdoor advertising should be retained only on Interstate highways outside the jurisdictions of municipalities and on federal-aid primary highways selected as scenic highways by the states.

11. Transportation System Management (TSM)

In order to create an incentive for the development of urban highway projects which improve the efficiency of existing highway systems, the federal government should give funding priority to projects which improve traffic flow on existing streets and highways, as alternatives to major new construction, especially in high density areas. Priority should also be given to street and highway improvements which benefit public transit, such as preferential lanes for high occupancy vehicles, ramp metering, computerized traffic control, one-way streets, reversible traffic lanes, traffic signal preemption for buses, parking management strategies, signal synchronization, and bicycle projects.

Federal policy should also continue to emphasize the proper management of existing transit systems and the implementation of low cost transit improvements. The effect of these activities will be to serve mobility needs as well as to reduce energy demand and to facilitate the improvement of air quality. Federal funding priority should be given to the development of: para-transit service; private sector transit service; ridesharing and transportation brokerage activities; park-and-ride facilities; express bus service, subscription bus service; auto free zones and transit malls; improved transit marketing; passenger information systems; and simplified fare collection procedures.

In addition, the federal government should eliminate legal and tax barriers to the implementation of ride-sharing projects.

Federal policy should further encourage proper transportation management by simplifying the procedures required for planning and implementation of federally funded TSM projects. While NLC recognizes that citizen participation and regional coordination are needed for effective execution of TSM projects, current requirements in these areas serve as a disincentive to localities wishing to implement TSM initiatives.

12. Urban Interstate Beltways

The federal government, in cooperation with local governments, should examine planned and partially completed urban interstate beltways to determine the social, economic, and environmental impacts of these beltways on urbanized areas. If it is determined that an urban beltway will have an adverse impact, then the federal and local governments should jointly decide whether or not to continue project planning and implementation. If it is determined that an urban beltway will have a positive impact, then the federal and local governments should jointly move to quickly implement the beltway and its accesses.

13. Highway Safety

All levels of government must continue and strengthen their efforts towards improving safety on highways, particularly interstate highways.

14. Disadvantaged Business Enterprise Requirements

The federal government should seek greater economic opportunity for minority entrepreneurs by encouraging greater use of minority contractors and subcontractors in federal procurement and financial assistance programs. DBE goals should be high enough to be effective, and enforcement should be reasonable and vigorous. Furthermore, a flexible, efficient waiver procedure should be instituted to take into account the percentages of minorities in an area and the availability of minority contractors.

15. Restructuring the Federal Highway Program

NLC supports restructuring the federal highway program into three categories: (1) an interstate 4R and the bridge program; (2) an urban and suburban program; and (3) a rural program.

The levels of federal funding in each category should be mutually agreed upon by the federal, state and local government groups.

Funds for the interstate 4R, bridge and rural programs should continue to be allocated to the states. Funds for the urban and suburban program should be allocated to the states, with a mandatory pass-through to cities or metropolitan planning organizations in urban and suburban areas above 200,000 population. The new federal program should allow the use of funds for local complementary arterials to the Interstate system as a way of relieving the congestion. Flexibility should also exist at the local level to allow some transfer of highway and transit funds to best meet local needs.

National League of Cities
Policy on Clean air

In order to be prepared in the event of a future oil embargo or supply disruption, the federal government should increase the rate at which petroleum is stockpiled in the Strategic Petroleum Reserve and should authorize and appropriate sufficient federal funds for this purpose.

6. *Coal*

Coal is the most abundant natural resource that we have in the United States. Clean coal technology should be pursued to ensure that our nation's communities have a clean, efficient and effective source of electricity and/or fuel for the future.

The requirements for development and retention of federal leases should be streamlined, balanced and evaluated to allow for effective and efficient development of this resource. The current federal policy of double taxes should be eliminated (tax on tax). Coal taxes should not exceed taxes on other energy sources. The transportation of coal, including slurry, should be considered and steps outlined to alleviate captive shipper inequities. Improving the transportation of coal will enhance both the domestic and export markets and contribute to energy security. NLC should encourage clean coal research grants by federal and state governments as well as the private sector to promote economical and environmentally sound use of this abundant resource.

7. *Energy Emergencies*

We may, because of another oil embargo or a disruption of the sea lanes, need to drastically and quickly reduce petroleum consumption. The repercussions of reduced petroleum availability would be acutely felt at the local level.

In order to respond to such a reduction, the federal government should help the nation's cities and citizens cope with the higher fuel prices. This should be done through a revenue turnback plan funded by the incremental federal revenues which result from a shortfall induced price increase. Local governments which have contingency plans in place should be eligible recipients of the turnback. A local role in determining the distribution of the state's allocated turnback should be mandated.

In the event that allocation controls are used during a petroleum shortfall, the government should take the following actions:

a. develop a national program to inform local elected officials of the procedures for obtaining fuel under the emergency petroleum allocation regulations;

b. mandate the inclusion of local governments in the development and implementation of the state "set aside" emergency petroleum reserve program;

c. alter the existing emergency allocation regulations to give priority to essential municipal public health and public safety services. Such services should receive 100 percent of their petroleum needs in the event of a shortfall;

d. take action, in conjunction with state governments, to expedite the delivery of gasoline and diesel fuel to local governments in the event of a shortfall;

e. adjust to emergency allocation regulations so that they do not discriminate against cities that have already cut gasoline consumption;

f. ensure that petroleum suppliers adhere to the allocation regulations in calculating fuel allotments to municipalities;

g. encourage development and use of local transportation systems and ridersharing programs in times of emergency;

h. establish a single office of emergency energy preparedness which would coordinate energy activities of federal, state, and local governments;

i. provide technical and financial assistance to local governments for the preparation of energy contingency plans;

j. enact incentives for the buildup of local petroleum stocks;

k. not preempt state and local price and allocation controls;

l. ensure that utilities and regulatory agencies inform and consult with officials of local government at the earliest possible stage of any plan for allocation and curtailment or load shedding; and

m. give the President standby emergency powers to respond to a clearly identified emergency with measures, including rationing, to cut gasoline consumption.

2.03 Air Pollution

A. Problems

Air pollution continues to be a serious threat to the health of our citizens and the welfare of our communities. While some progress was made in the 1970's in controlling emissions from stationary sources of pollution, transportation-related pollutants are a persistent and growing threat. Concern of urban residents about air pollution continues to be high.

Reducing air pollution to safe levels is, therefore, equal in importance with employment, housing and economic development in revitalizing and conserving cities. In areas with clean air, degradation of air quality may be a threat to agriculture, forest lands, tourism and the economic base of rural municipalities. Migration of pollution from one area to another, such as the acid rain problem, is an increasing threat to both non-attainment and clean air areas.

B. Goals

1. *National Strategy*

All levels of government and private industry must take concerted action to attain and maintain clean air. We also must prevent degradation of existing air quality and attain the goal of clean air. A national clean air strategy must be developed to attain national air quality standards and to protect the public health and welfare, and to do so within a reasonable time.

2. *Linkage To Transportation Systems*

Components of urban transportation systems, particularly single-passenger automobiles, under utilized transit, paratransit and rail systems, trucks and motorcycles have been shown to be major contributors to air pollution problems in urbanized areas. One of the primary objectives of urban transportation systems should be to prevent degradation of air quality in clean air areas, and to promote attainment of clean air in areas which exceed public health levels.

3. *Protection of the Outer Ozone Layers*

The federal government should restrict the use of materials processed with fully halogenated chlorofluorocarbons which pose a threat to the protective outer ozone layers.

C. Policies

1. *Local Role*

The Clean Air Act as amended recognizes that the primary responsibility for achieving clean air is with state and local governments. To date, many local governments have been given little state and federal support and cooperation. The federal government should explicitly strengthen the direct role of cities in air pollution prevention and control. Authority to conduct air quality planning should be vested with general purpose local governments or regional policymaking organizations, a majority of which are composed primarily of local elected officials. Authority to implement and enforce air quality plans should be jointly determined by state and local governments, consistent with state and federal law and with comprehensive state and regional air quality control standards.

2. *State Implementation Plans (SIP)*

EPA must continue to review the development of the basic elements of state implementation plans to ensure that every state is meeting minimum federal requirements and is moving toward attainment of national ambient air quality standards as expeditiously as possible. However, EPA's oversight of every aspect of SIP development and implementation is duplicative, time-consuming, and unnecessary, and actually inhibits the rapid achievement of cost-effective emission reductions.

State and local governments should generally be allowed to grant or alter permits without the need for federal approval as long as such actions are consistent with EPA-approved generic permit-rules.

EPA should be required to review individual permits only for the largest sources and those with interstate impact. However, local governments should be able to obtain EPA review of any state permitting decision or other minor SIP revision not otherwise needing EPA approval.

Whenever EPA approval of any SIP element is required, EPA should (where consistent with the Administrative Procedures Act) participate in the state or local SIP promulgation process, and should be required to take final action within a reasonable time after state promulgation.

3. *State-Local Joint Determination*

EPA should be required to exercise greater oversight to ensure that states do not undertake pollution control activities unless such activities were authorized by a joint determination of state and local elected officials. In particular, any transfer of emission credits (offsets) from one local jurisdiction to another should be permitted only where agreed to by affected local governments.

Local elected officials having jurisdiction over the territory must be equal partners with the state in development of plans to prevent significant deterioration of air quality in clean air areas, or for achieving clean air in nonattainment areas.

4. *Federal Assistance*

To support efforts to achieve federal clean air mandates, increased federal assistance to local governments is needed. Federal funds should go directly to local agencies with SIP development or enforcement responsibilities and such agencies should be permitted to adopt and implement their own SIP's without state review, where permitted by state law. The federal government also should expand financial assistance to local governments beyond emission control and monitoring to areas such as land-use and transportation planning.

5. *Primary Standards*

Minimum federal ambient air quality standards should be adequate to protect the public health and welfare, with the option for state and local governments to adopt stricter standards. Primary air quality standards should continue to be based on health considerations alone, with a sufficient margin of safety to ensure the health of even the most susceptible individuals from adverse effects. However, state and local implementation of the primary standards should be changed so that it is no longer dependent upon questionable and imprecise mathematical models. Instead, states and localities should be required to implement specific pollution control technologies, depending on the severity of the pollution problem in their jurisdiction, which would enable those jurisdictions to reduce emissions.

6. *Secondary Standards*

EPA should continue to set secondary ambient air quality standards to protect non-health related values.

7. *Evaluation*

The federal government should continue to evaluate the National Ambient Air Quality Standards to ensure they are attainable and necessary for the health and welfare of our citizens. Recognizing that climate, geography, and the transport phenomenon play critical roles in persistent nonattainment areas, research should be undertaken to develop new control strategies and to assure that control measures result in progress toward attainment.

EPA standards for Air Quality should be flexible enough to consider regional physical conditions in the development of PM-10 standards.

8. *Deadlines*

To ensure a nationally uniform effort to achieve safe pollution levels, reasonable attainment deadlines must be established.

Where it can be demonstrated that existing statutory deadlines for specific pollutants are unattainable for large numbers of nonattainment areas, the Clean Air Act should be amended to extend such deadlines. Congress should give EPA the authority to grant extensions for limited periods of time to areas which will not attain the NAAQS by the statutory deadlines even after submitting a pollution control plan and implementing all reasonably available stationary and mobile source controls. The extension should be contingent upon an area's implementation of additional pollution controls beyond those specified in the State Implementation Plan, depending upon the severity of the pollution problem in the area. The extension should be granted only after ample justification is presented at open public hearings.

9. *Sanctions*

Congress should require EPA to impose sanctions on areas failing to: submit a State Implementation Plan outlining measures which will reduce pollution from stationary and mobile sources; revise the SIP in accordance with EPA specifications; and implement the measures identified on the SIP.

Congress should eliminate from the Clean Air Act those sanctions which are environmentally counterproductive. Specifically, EPA should not be allowed to withhold grants to states for the administration of clean air programs where the state's nonattainment was caused by a problem other than the state's failure to prepare a SIP. Nor should EPA be allowed to withhold grants for the construction of municipal wastewater treatment facilities since such action would impede progress toward attainment of national clean water goals.

EPA should be given greater discretion to impose a graduated set of sanctions so that the penalties imposed can be tailored to the severity of the violations committed. Furthermore, sanctions should be imposed on the level of government or agency directly responsible for the noncompliance.

EPA should modify its policy on sanctions by allowing construction of new sources of major modifications of existing sources where such sources perform essential governmental functions, such as resource recovery. For all other sources, new construction and major modifications should be allowed only if emissions from existing sources are reduced by an amount equal to twice the level of the added emissions from the new or modified source.

10. *Motor Vehicle Emissions*

Where pollution is caused by motor vehicles, the primary means for abatement of such pollution should be direct and stringent controls on motor vehicles.

The current Clean Air Act Motor Vehicle Emission Standards, including those for high altitude areas, should be maintained. The standards for light and heavy duty trucks should be tightened for those emissions (such as hydrocarbons) which contribute to ozone formation. There should be no relaxation of current vehicle emission regulations which would lead to significant increases in emissions. Further, Congress should enact and EPA should develop and promulgate standards for diesel fuel burning vehicles, heavy trucks, and buses as soon as possible.

Where emissions standards are set too low because of inadequate existing control technology, the federal government should commit itself to supporting the development of more adequate technology. The federal government, for example, should initiate a program to research, develop, and demonstrate alternatives to the internal combustion engine.

In order to reduce the level of carbon monoxide emissions caused when an automobile is started in cold weather--a phenomenon known as a "cold start"--several steps should be taken. For one EPA should design a vehicle emissions test which accurately reflects the real world conditions under which automobiles are operated (including cold temperatures) and which focuses on the cold start portion of the driving cycle. Secondly, the Agency should develop a technological solution to reducing cold start emissions. Third, EPA should establish automobile performance standards requiring manufacturers to produce automobiles which emit less carbon monoxide during cold starts in cold temperature conditions.

The federal government also should expedite the development, testing and commercialization of alternative fuels (such as ethanol, methanol and gasohol) which cause fewer harmful emissions than do gasoline and diesel fuels.

EPA should promulgate regulations on gasoline volatility and on gasoline vapor recovery systems as quickly as possible so as to reduce the harmful level of hydrocarbon emissions caused by evaporation of gasoline vapors during the refueling of motor vehicles.

Finally, the federal government should tighten the standards for controlling harmful emissions from motor vehicles while they are in actual use. This could include, but not be limited to, enhanced vehicle inspection and maintenance program requirements, national anti-tampering requirements for in-vehicle pollution control equipment, and national requirements to prevent fuel switching.

11. Evaluation of Transportation Control Measures (TCM's)

The federal government should continue to evaluate the relationship between transportation controls, vehicle miles traveled, and air pollution, as well as demonstrate and document the effect that each transportation control will have an ambient air quality.

12. Implementation of TCM's

In areas projecting attainment and making projected-yearly progress toward attainment by the statutory deadline (currently 1987), implementation of transportation control measures should not be a mandatory federal requirement. Any area needing an attainment extension for ozone or carbon monoxide, however, should be required to implement vehicle inspection and maintenance and all other transportation control measures found, after analysis, to be cost-effective and reasonably available for their area.

13. Emission Controls

Strict emission control requirements should be maintained on all new sources, whether located in clean or dirty air areas. New source permits should continue to be required for all"major" sources which result in significant emission increases. However, once a permit has been issued for a source, it should be exempt from additional requirements for a reasonable period of time.

14. Nonattainment Areas

Because expeditious attainment of air quality standards is critical to public health, there should be no weakening in new source requirements for nonattainment areas. Specifically, the requirements for lowest achievable emission rates and the emission offset program should be retained. In addition, the actual attainment status of "unclassified" areas should be determined before any permits are issued in these areas, so that industry is not enticed to locate on the periphery of urban areas by more lax permitting requirements.

15. Prevention of Significant Deterioration (PSD)

Air resources already meeting secondary standards should be protected to facilitate the maintenance of national clean air objectives.

Where the current PSD program leads to unnecessary delays in new and modified source permitting, efforts should be made to streamline and simplify the current requirements. The preconstruction monitoring requirement should be eliminated, the permit approval process should be shortened, states should be allowed to classify areas subject to PSD requirements, and requirements for permit modifications should be eased.

However, PSD increment system should remain intact. The increment system, over the long term, is needed to ensure that PSD area permitting agencies require strict"best available control technology" (BACT) for new sources.

Such BACT determinations are needed not only to protect existing air quality and preserve room for future growth in PSD areas, but also to ensure that nonattainment areas are not unfairly disadvantaged in their efforts to attract and retain industry.

16. Hazardous Pollutants

In 1970, Congress established a program to control hazardous pollutants, pollutants which can cause death, serious diseases or other adverse health effects from industrial sources.

Congress should continue to require EPA to identify and set standards for hazardous pollutants which protect public health by an ample margin of safety and which preserve the environment. EPA should be directed to impose controls on sources of hazardous pollutants which are stricter than technology-based standards where necessary to protect public health and the environment. Congress should establish deadlines for the determination of those substances which are hazardous and should require mandatory listing of substances where EPA fails to meet the deadlines.

17. Interstate Transport

The transport of pollutants between states as well as between areas within individual states, represents a major air quality problem which the current Clean Air Act provisions are clearly inadequate to remedy. Congress should direct EPA to designate major pollution transport regions consisting of attainment and adjacent nonattainment areas. Within a designated region, an attainment area which adversely impacts a nonattainment area should be required to install reasonably available controls on stationary sources of pollution unless the attainment area can demonstrate it is not a contributor to the ozone or carbon monoxide problem of the nonattainment area.

18. Acid Deposition

Congress and the Administration should recognize that the transboundary nature of acid deposition calls for solutions that transcend the jurisdiction of any one local or state government and that the Clean Air Act does not currently provide sufficient authority to regulate all long-range transported air pollution. Specifically, the following actions should be taken:

a. Congress should amend the Clean Air Act by enacting acid rain control legislation which meets reasonable standards of effectiveness, economy and equity. Such legislation should require substantial reductions in sulfur dioxide emissions and nitrogen oxide emissions over a long-term period from both stationary and mobile sources. The emissions reduction program should be divided into two phases. The intent of the two-phased approach is to allow utilities to phase in their control strategies and to allow mid-course corrections in the federal program.

   Congress should establish a near-term emission reduction target in phase one. EPA should specify the level of emissions reduction by source type and state; however, the governor should have the authority to allocate emissions reductions to individual sources within the state. Each state should be allowed to achieve the specified levels of emissions reductions through any method, including the most cost effective one, and states and sources should be allowed to trade emissions reductions.

In phase two, Congress should establish final emission reduction targets. Congress should also direct the EPA or the National Academy of Science to study whether the program is achieving its objectives and whether the emission reductions targets should be altered. Acid rain problems in other parts of the country should also be examined. Congress should then allow for mid course corrections to the final reductions targets based on the study findings.

b. Congress should fund an acid rain compliance program through a fee on nonexempt electricity generation within the 48 contiguous states. Electricity generated from hydroelectric and other renewable energy facilities, nuclear powerplants, and electric utility plants currently in compliance with new source performances standards should be exempted from the user-fee requirement. The intent of such a fee is to distribute, on an interstate basis, a portion (e.g. one-third) of the compliance costs for the purpose of tempering disproportionate rate increases and mitigating the adverse impacts of the emissions reductions requirements on employment. Electric utilities should have the discretion to include their financial contribution to the compliance program as a line item on utility bills.

In addition, Congress should enact a fee on other fossil-fueled sources (such as industrial boilers) and mobile sources which contribute to the acid rain problem.

The resulting funds should be used to finance the capital costs of whatever control methods are deemed appropriate by the state. States should consider the cost-effectiveness of the control method, the effect of the emissions reductions measures on the useful remaining life of the facilities, the impact of the measure on sensitive receptor areas and the availability of the control method;

c. The federal program should provide for expanded federal and state ambient acid deposition monitoring using standardized methods of sampling and analysis. The intent of such monitoring is to provide a better information base and to gauge the effectiveness of the emissions reduction program.

d. The federal government should recognize the offer of the government of Canada for a significant bilateral reduction in sulfur dioxide emissions and should conclude negotiations and adopt a treaty committing both countries to this goal. Both countries should be required under the treaty to demonstrate their efforts to achieve the emissions reduction goal. A similar treaty should be negotiated with the Mexican government.

e. Congress should direct EPA to increase research and demonstration of new, less expensive technologies for reducing sulfur and nitrogen oxides, and to develop economic uses for by-products of pollution control technologies.

2.04 Solid and Hazardous Waste

A. Problems

The disposal of wastes and the conservation of resources are two of the most challenging problems to be solved by this nation. With almost half of our cities running out of current disposal capacity in the next two to three years, America's urban areas face an immediate disposal crisis.

Additionally, the improper disposal of hazardous waste and the spills of chemicals, oils, and other hazardous substances as the result of highway, rail and waterway accidents are national problems which can endanger public health and pollute our nation's air, water and land resources. A solution to the hazardous waste and materials problem will require the cooperation of federal, state and local governments as well as the hazardous waste generating industries and materials transporting industries.

B. Goals

The crisis of solid waste management must be solved through an aggressive program of source reduction, volume reduction, resource recovery, and ultimate disposal all of which must be compatible with the environment.

A national hazardous wastes and materials management strategy must be developed in order to protect human health and the environment. The strategy should encompass the entire life of the waste and material, from reproduction to transportation and temporary storage to final disposition.

C. National Solid Waste Policy

A national policy for solid waste management should take an integrated approach to effectively mix and match management options to best meet local needs.

To assist city officials' efforts to effectively address this crisis, the federal government must support the following management options.

1. Source Reduction

The federal government should support public education programs to enhance a better understanding of the crisis and to promote public participation in options to reduce the volume of solid waste. Federal packaging standards should be established for manufacturers, distributors and retailers to achieve maximum feasible reduction. Congress should enact legislation which will identify and remove from the waste stream packaging and products which are toxic and not recyclable and/or biodegradable. Federal

Saudi King Foresees $26 A Barrel Oil By 1990

If the Organization of Petroleum Exporting Countries respects production quotas, crude oil prices could reach $26 per barrel by early next year, predicted King Fahd of Saudi Arabia last Tuesday.

In a statement published by the Kuwaiti newspapers *Al Siyassah* and *Arab Times*, the King said, "I expect oil prices to reach $26 at the beginning of the next year, provided production ceilings are strictly adhered to."

The Saudi announcement underscored the increasing pressure it is placing on other oil producers in the Persian Gulf region such as Kuwait and the United Arab Emirates to follow higher production quotas in order to keep prices strong. Saudi Arabia controls about 24% of OPEC production, about 18 million barrels per day.

OPEC plans to meet in early June to discuss its production and pricing policies.

Denver Area Oxy-Fuel Program Wins High Marks

-Air Quality Council Votes To Raise Oxy-fuel Standard Next Season-

Following the Colorado Front Range's second successful oxygenated fuel program, the Metropolitan Air Quality Council voted last week to increase the oxygen standard of the gasoline from the current 2.0% (wt.) to 2.7% (wt.) when the program resumes this November.

Considered to be the leading air quality planning agency for the Denver area, the council rejected suggestions by the state health department to end the required oxy-fuel program a month early on Jan. 31 and not increase the oxygen standard. A wintertime oxygenated fuel standard has been required in the Front Range since January 1988. Using cleaner-burning fuels that contain oxygenates such as ethanol or methyl tertiary butyl ether (MTBE) reduced carbon monoxide levels in the Denver area by 12%, the health department said last March.

Council members will make their recommendations to the Colorado Air Quality Control Commission May 18.

Increasing the oxygen content of the gasoline to 2.7% this winter will reduce carbon monoxide emissions an additional one percent for 1982 and later car models and an extra 20 to 30% for vehicles built before 1982. According to the *Denver Post*, about half of the cars along the Front Range fall into each category.

Several other Southwestern urban areas, which suffer wintertime carbon monoxide problems, have followed Denver's lead and have established their own oxygenated fuel programs.

Oxy Fuel Programs In The U.S.

City	Year Began	Minimum Oxygen Standard (by weight)
Denver	1988	2.0%
	1989	2.7%[1]
Phoenix	1989	2.3%
Tucson	1989	1.8%[2]
Las Vegas	1989	2.5%
	1990	2.6%
Reno	1989	2.0%
Albuquerque	1989	3.1%[1]

1 Proposed
2 Voluntary Program

OXY-FUEL NEWS

A Weekly Update and Analysis Of Oxy-fuels, Gasoline, and the Environment Worldwide

Monday, May 8, 1989

President Bush Maintains Alternative Fuels Commitment

-DOE Secretary Includes Oxy-fuels As Part Of Integrated Energy Policy-

At a top level White House staff meeting last week and earlier this month before the Texas state legislature, President George Bush pressed for the expanded use of alternative fuels.

His actions are seen as a growing indication that the president is committed to making clean-burning fuels such as ethanol, methanol and natural gas part of a national energy policy, said policy analysts last week.

(Continued on p2)

Trade Subcommittee Adopts CBI Ethanol Compromise

-Both Domestic, Caribbean Ethanol Industry Accept Decision-

The Trade Subcommittee of the U.S. House Ways & Means Committee last Thursday unanimously adopted a provision in new Caribbean Basin Initiative (CBI) legislation which set forth a compromise on fuel ethanol produced in the region.

Under the agreement, new language will amend the "domestic content" and "value-added" provisions of the 1986 Tax Reform Act for fuel ethanol produced in the CBI not subject to the $0.60 per gallon import tariff.

(Continued on p6)

Albuquerque City Council Passes 3.1% Oxygen Standard

-Motion Is Expected To Pass County Air Quality Board Easily-

The Albuquerque City Council last Monday unanimously passed C/S R-279, a city ordinance to establish a 3.1% (wt.) average oxygenated fuel standard, which was approved on a 5-0 vote by the Public Works and Environment Committee the week before (see *Oxy-Fuel News*, 5/1/89, p3). The ordinance must now be adopted by the Bernalillo County Air Quality Board before going into effect.

(Continued on p2)

Texaco Calls For Industry Solution To Dirty Air Problems

-President Proposes Spirit Of Cooperation Between Oil & Auto Companies-

Amid calls by the state and federal government for cleaner burning fuels, Texaco President James W. Kinnear said that both the oil and automotive industry should better examine the issue of whether the emissions improvement needed to assure healthy air can be achieved without replacing gasoline with methanol or other alternative fuels.

"We need to examine more fully . . . if emissions improvement . . . can be achieved by a redesigned clean emissions system based on the existing gasoline engine," said Kinnear at a speech before the Detroit Economist's Club last Monday.

(Continued on p4)

Inside *Oxy-Fuel News* . . .

Daschle, Others Urge EPA To Reduce Mobile Source Benzene p3
Chrysler Unveils New Methanol Research Vehicle p5
Saudis Foresees $26 A Barrel Oil By 1990. . . . . p9
Denver Area Oxy-Fuel Program Wins High Marks p9

PUBLISHER, FREDERICK L. POTTER • EDITOR, MAUREEN LORENZETTI • V.P. OPERATIONS, BURL HAIGWOOD • GOVERNMENT AFFAIRS, JAMES PEEPLES
• 499 SOUTH CAPITOL STREET SW • SUITE 406 • WASHINGTON, D.C. 20003 • 1-800-USA-FUEL OR (202) 554-0614 • TELEX 314383 • TELECOPY (202) 554-0613 •

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President Bush Supports Oxy-Fuels . . . *(Continued from p1)*

Bush met with C. Boyden Gray, council to the president, and John Sununu at an April 29 staff meeting and asked what the administration had done in response to a March 2 request "to move ahead on ethanol."

Both Gray, an alcohol fuel supporter in his own right, and Sununu assured the President that ethanol would be a part of the Administration's clean air proposal, according to White House sources.

And in a brief address before the Texas legislature April 25, Bush stressed the need to increase different types of energy including alcohol fuels, nuclear power and domestic oil production as a way to ensure national security.

"We must produce more of our corn crop to produce ethanol, more of our natural gas to produce methanol. Greater use of these two will rapidly improve the air quality of our most heavily populated cities," he said.

Bush administration officials are expected to release a proposal for new Clean Air Act legislation sometime this June. As part of the plan, officials are reportedly exploring the possibility of calling for a 3.0% (wt.) oxygenated fuel standard for areas not meeting federal air quality standards. Such a move would dramatically increase demand for oxygenated fuels such as methyl tertiary butyl ether (MTBE), fuel ethanol, methanol, and other ethers such as tertiary amyl ether or ethyl tertiary butyl ether.

In a related action, Secretary of Energy Secretary James D. Watkins cited the expanded use of alternative fuels such as ethanol, methanol and natural gas along with aggressive exploration of domestic oil as ways to achieve a balanced energy policy.

In a meeting with reporters April 27, Watkins acknowledged that there should be a new nationwide energy strategy which includes a "mix" of renewable energy coupled with more traditional sources of power such as coal, oil, and nuclear power.

"There is no question that we're moving aggressively, in my opinion, to get into alternative fuels, to flexible fuel mixtures. Ford Motor Company, General Motors are already building cars along those lines. Hopefully, they can take then any kind of gas mixture whether oxygenated, gas or otherwise---ethanol, methanol and the like, where the car can absorb that and make the proper adjustments and keep it running," he said.

"All those things are coming along, but we're not going to turn this around overnight."

Watkins recently joined several other administration officials such as William Reilly, administrator, U.S. Environmental Protection Agency, and Secretary of Agriculture Clayton Yeutter in endorsing ethyl tertiary butyl ether (ETBE), an oxygenated octane enhancer. Watkins did not take an official position on the clarification of the extension of the alcohol blender tax credit toward ethanol used to make ETBE.

Albuquerque Sets 3.1% Oxy-Fuel Standard . . . *(Cont from p1)*

The move will give the Albuquerque area the nation's highest oxygenated fuel standard when the ordinance goes into effect on October 1 of this year.

The Bernalillo County Air Quality Board will begin the rulemaking process with hearings on May 10. No significant problems are anticipated with the plan which involves averaging higher-oxygen content fuels which will only be blended "at the last point of wholesale distribution," according to the language of the ordinance. This provision ensures that "clean," or non-oxygen containing base gasolines, will be made available for terminal blending of 10% ethanol, or MTBE.

The ordinance also provides for an oxygenate averaging mechanism allowing each refiner selling gasoline locally can average the oxygen content of its own fuels, as well as transfer or receive "oxygen credits" to or from others.

National
League
of
Cities

1301 Pennsylvania Avenue N.W.
Washington, D.C.
20004
(202) 626-3000
Fax (202) 626 3043

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May 8, 1989

The Honorable Joseph Lieberman
United States Senate
123 Senate Hart Office Building
Washington, D. C. 20510

Dear Senator:

On behalf of the National League of Cities and the 16,000 cities and towns we represent, I would like to thank you for your interested attention at the recent infrastructure hearings before the Subcommittee on Federalism.

Your expression of concern -- as a member of the Senate Environment Committee -- about the conflict between potential Clean Air Act requirements to reduce vehicle miles traveled and the inclusion of VMT in the allocation formula for highway funds was indeed appreciated.

Another clean air issue which could have a more delayed impact on transportation resources will be the mandatory use of alternative fuels. As you know, ethanol, gasohol, and methanol are exempt from the gas tax -- the primary source of funding for the highway program. As the use of these alternative fuels increases over time, DoT estimates a potential negative impact on the highway trust fund of $600 million to $1 billion annually.

While we have no quarrel with either of these measures as tools for reducing air pollution, we do believe Congress should be fully informed and aware of the potential consequences of their decisions. Transportation resources, such as road improvements funded with highway trust fund revenues or mass transit improvements funded from the mass transit account of the highway trust fund, also contribute to improvements in air quality by reducing congestion. It is always possible that reductions in VMTs and resulting declines in highway resources could net out even in terms of air quality improvements.

Past Presidents: [illegible]

The Honorable Joseph Lieberman
May 8, 1989
Page Two

We have no easy answers to these conflicts. Reductions in VMTs, especially in areas without the population densities that can support a viable mass transit alternative, will be difficult to implement under the best of circumstances. We both know how wedded Americans are to the convenience of their automobiles.

Enactment of measures to extend the gas tax to alternative fuels will also be no mean feat for the U.S. Congress. Agricultural interests, which from our perspective seem to have some special dispensation from contributions to deficit reduction, will resist such moves vigorously.

Again, Senator, we appreciate your recognition that we face some difficult decisions. If we can be of any assistance to you and the committee in trying to resolve these conflicts, we certainly stand ready to help.

Sincerely,

Burton Stallwood

Burton Stallwood
Town Administrator of Lincoln, Rhode Island
Chairman
Energy, Environment and Natural Resources Committee

Senator **Bingaman**. Thank you very much. It is obvious you and the city council, as the National League of Cities, are involved in some very exciting efforts to try to come to grips with this complex set of issues.

Our final witness is Ray Peterson, who is the Transit Director for the City of Las Cruces. This hearing until now has focused primarily on the problems of Albuquerque, because that sort of was the impetus for having it, is the EPA sanctions imposed on Albuquerque. I think that got the working group together, and that is what resulted in our doing this day of attention to the problems. But we are very anxious to find out what Las Cruces' situation is; and if there are things we need to know that relate to the Clean Air Act in particular. So we are glad to have you here.

STATEMENT OF RAY PETERSON, TRANSIT DIRECTOR, CITY OF LAS CRUCES, NM

Mr. **Peterson**. Thank you. Good morning, Mr. Chairman and Senator Domenici. I am here also representing the American Public Transit Association.

The mass transit community stands ready to play its role in reducing air pollution in our country. This is a war we cannot lose or we will surely perish. Air, like water, is essential to sustain life. America's love affair with the private auto has turned into a fatal attraction. Our lover, the auto, is slowly killing us.

The ramifications are clear. Auto availability and use will continue to increase, but the cost, convenience and consequences of personal vehicle travel are likely to deteriorate significantly in more and more areas of the country, heightening the need for new options and strategies to enhance mobility.

With more cars on the road our quality of air will continue to deteriorate.

Worsening air quality represents a growing crisis for the nation. The facts that relate our air quality problems to motor vehicle use and, particularly, our reliance on single occupancy vehicles, are undeniable.

Reduced vehicle emissions are critical in the effort to improve air quality. Major reductions from new auto technology however, will be offset by projected growth in total travel demand. It appears, therefore, any success in reducing air pollution will require strategies that seek to alter travel behavior, including efforts to increase ridership on transit and other high-occupancy modes.

The U.S. Environmental Protection Agency in response to air quality problems, has issued regulations to attempt to control these problems. As part of these regulations the EPA requires transit buses to meet a standard for diesel particulate emissions, beginning in 1991, that is stricter than the standard applicable to heavy-duty diesel trucks. APTA has petitioned the EPA to change the federal regulations for a more uniform compliance timetable for buses and heavy-duty diesel trucks.

The petition was based on conclusions of the APTA clean air task force that the 1991 bus standard is not feasible given current and anticipated diesel engine technology and the yet-unproven reliability and dependability of alternate fuels in regular transit service.

The Transportation Manufacturing Corporation [TMC] of Roswell, New Mexico, has built some experimental methanol powered buses for urban service. Results of this equipment have been mixed. Cleaner emissions have resulted from methanol powered vehicles, but much higher costs have occurred also. The price of methanol is expected to be about the same as diesel but performance is less than diesel. The prototype methanol buses are showing fuel consumption of 2.6 times more than regular diesel engines. This drives the costs up to run the same service on the streets. The major cost to transit systems will be the on-site fuel changeover from diesel to methanol. Cost estimates in Los Anageles and Denver are around $1 million. How can a small transit system like Las Cruces, New Mexico, afford this extraordinary cost? Most transit systems do not have the resources available that Denver and Los Angeles have to experiment.

APTA is requesting more breathing room, until 1994, in order for the industry to meet the new air quality standards. Diesel powered buses cannot meet the EPA standards during the 1991–1993 time frame. With the high cost of alternate fuels technology and no diesel engines able to meet the standards, transit systems will have no choice but to delay the purchase of new buses until 1994. This course will be a disaster for transit systems and bus manufacturers. In 1994 it is expected that complying diesel engines will be available.

So far, I have discussed the technology side of this issue. Now I wish to present the cost realities for most transit systems. Since 1981, the Federal partnership with local transit in sharing costs has been reduced about 50 percent. In small transit systems this Federal drop in funds is causing us to stop expansion or even replacement of existing vehicles. We can no longer purchase buses or large cost items, such as methanol conversation facilities from the amount of Federal funds available. With the air quality problems it should be unthinkable to even consider further reductions in mass transit funding. Instead we must be working to increase transit ridership as part of the effort to reduce air pollution, traffic congestion, and conserve scarce fuel resources.

Las Cruces, New Mexico, was recently listed as the eighth fastest growing city in the United States. We also are one of the lowest per capita income cities in the United States. This limits our ability to tax citizens. Recently the local voters rejected a one quarter of 1 percent increase in sales taxes to support police, fire and transit services, the most essential of public services. With Federal funds diminishing, very little ability to raise taxes locally, rising costs, no capital funds to use alternate fuels technology, and air quality problems we are caught in a situation that will have disastrous results in the near future.

Without increased Federal aid, cities will not be able to respond to air quality programs with mass transit as a partial solution. What the transit industry needs to help reduce air pollution is relaxation of the EPA standards until 1994, increased Federal capital and operating funds for expansion and a rethinking of the role of mass transit and automobiles in our lives with more incentives to use mass transit rather than the private auto. If we are successful by implementing the above actions, then we can reduce air pollution while encouraging economic growth and a future for life on our planet.

[The prepared statement of Mr. Peterson follows:]

STATEMENT OF THE

AMERICAN PUBLIC TRANSIT ASSOCIATION
BEFORE THE

SUB COMMITTEE ON MINERAL
RESOURCES DEVELOPMENT
AND PRODUCTION

UNITED STATES SENATE
HONORABLE JEFF BINGAMAN, CHAIRMAN
MAY 25, 1989

NEW MEXICO CONFERENCE CENTER
ALBUQUERQUE, NEW MEXICO

STATEMENT OF THE AMERICAN PUBLIC TRANSIT ASSOCIATION BEFORE THE SUBCOMMITTEE ON MINERAL RESOURCES, DEVELOPMENT AND PRODUCTION
U.S. SENATE

Good morning Mr. Chairman and members of the subcommittee. APTA appreciates the opportunity to express its views on strategies for combatting air pollution. My name is Ray Peterson and I am the Transit Director for the City of Las Cruces, New Mexico.

The mass transit community stands ready to play its role in reducing air pollution in our country. This is a war we cannot lose or we will surely perish. Air, like water, is essential to sustain life. Americas love affair with the private auto has turned into a fatal attraction. Our lover, the auto, is slowly killing us.

In APTA's publication, "transit-2000", the following are predicted to occur if present trends continue:

- Household auto ownership is expected to increase past the point where, on average, an automobile will be available for every employed person;
- Congestion is now a common feature of urban and suburban travel and will increase more than 400% over the next 20 years on the nation's freeway systems and over 200% on non-freeways, according to the Federal Highway Administration; in areas under one million population, freeway congestion will increase over 1000%;
- The most conservative estimates indicate that total travel is expected to increase one or two percent per year. This would add to the current roadway system over the next 32 years the same amount of new traffic that has been added in the last 32 years;
- An estimate of the staggering cost of congestion on our urban freeways alone, published in a recent Transportation Research Board report, concluded that in the next 20 years:

-- annual delay will increase by 5.6 billion hours;

-- excess fuel consumption will increase by 7.3 billion gallons per year;

-- total costs to travelers will increase by $41 billion per year;

- Estimates by state highway officials indicate a need for 102,000 new lane miles of highway on new alignments; expectations are that it will not be possible to construct all these facilities; if 20% cannot be built, the demand for public transportation will double.

The ramifications are clear. Auto availability and use will continue to increase, but the cost, convenience and consequences of personal vehicle travel are likely to deteriorate significantly in more and more areas of the country, heightening the need for new options and strategies to enhance mobility.

With more cars on the road the quality of our air will continue to deteriorate.

Worsening air quality represents a growing crisis for the nation. The facts that relate our air quality problems to motor vehicle use and particularly, our reliance on single occupancy vehicles, are undeniable:

- Sixty-eight cities are too polluted to meet standards for ozone; 59 cities fail to meet standards for carbon monoxide pollution; Over 100 suburban areas exceed current pollution standards;

- Motor vehicles are a major cause of carbon dioxide, the pollutant that promotes global warming via the greenhouse effect; motor vehicles also contribute 60 percent of the hydrocarbons that produce the ozone and smog problem;

- The effects of persistent or worsening air pollution are now known to affect everyone, not just those with respiratory problems; over 100 million Americans now live in areas where air quality is below acceptable standards; the American Lung Association estimates the national health care bill for air pollution illness is $40 billion per year;
- Ozone accumulation at ground level threatens the long-term economic viability of entire industries; crop losses due to ozone, smog and other air pollutants in the U.S. each year equals $1.3 billion;
- The U.S. Environmental Protection Agency must now begin applying sanctions and limiting development in non-attainment areas; EPA Administrator Lee M. Thomas has repeatedly stated that "solving the urban ozone and carbon monoxide problem will require us to change our driving habits."

Reduced vehicle emissions are critical in the effort to improve air quality. Major reductions from new auto technology, however, will be offset by projected growth in total travel demand. It appears, therefore, any success in reducing air pollution will require strategies that seek to alter travel behavior, including efforts to increase ridership on transit and other high-occupancy modes.

The U.S. Environmental Protection Agency, in response to the air quality problems, has issued regulations to attempt to control these problems. As part of these regulations the EPA requires transit buses to meet a standard for diesel particulate emissions, beginning in 1991, that is stricker than the standard applicable to heavy-duty diesel trucks. APTA has petitioned the EPA to change the federal regulations for a more uniform compliance timetable for buses and heavy-duty diesel trucks.

The petition was based on conclusions of the APTA clean air task force that the 1991 bus standard is not feasible given current and anticipated diesel engine technology and the yet-unproven reliability and dependability of alternate fuels in regular transit service.

The Transportation Manufacturing Corporation (TMC) of Roswell, New Mexico, has built some experimental, methanol powered buses for urban service. Results of this equipment have been mixed. Cleaner emissions have resulted from methanol powered vehicles but much higher costs have occurred also. Currently the vehicle is about 22% higher in cost to purchase. The price of methanol is expected to be about the same as diesel but performance is less than diesel. The prototype methanol buses are showing a fuel consumption of 2.6 times more than regular diesel engines. This drives the costs up to run the same service on the streets. The major cost to transit systems will be the on-site fuel change over from diesel to methanol. Cost estimates in Los Angeles and Denver are around $1 million. How can a small system like Las Cruces, New Mexico, afford this extraordinary cost? Most transit systems do not have the resources available that Denver and Los Angeles have to experiment.

APTA is requesting more breathing room, until 1994, in order for the industry to meet the new air quality standards. Diesel powered buses cannot meet the EPA standards during the 1991-1993 time frame. With the high cost of alternate fuels technology and no diesel engines able to meet the standards, transit systems will have no choice but to delay the purchase of new buses until 1994. This course will be a disaster for transit systems and bus manufacturers. In 1994 it is expected that complying diesel engines will be available.

At this point, I would like to submit the APTA petition to the U.S. Environmental Protection Agency to modify the 1991 particulate Emission Standards for urban transit buses for inclusion into the record so that members of this committee may have an opportunity to review our entire presentation on this issue.

So far, I have discussed the technology side of this issue. Now I wish to present the cost realities for most transit systems. Since 1981, the federal partnership with local transit in sharing costs has been reduced about 50%. In small transit systems this federal drop in funds is causing us to stop expansion or even replacement of existing equipment. We can no longer purchase buses or large cost items such as methanol conversation facilities from the amount of federal funds available. With the air quality problems it should be unthinkable to even consider further reductions in mass transit funding. Instead we must be working to increase transit ridership as part of the effort to reduce air pollution, traffic congestion, and conserve scarce fuel resources.

Las Cruces, New Mexico, was recently listed as the 8th fastest growing City in the U.S. We also are one of the lowest per capita income cities in the U.S. This limits our ability to tax citizens.

Recently the local voters rejected a 1/4% increase in sales taxes to support police, fire and transit services (the most essential of public services). With federal funds diminishing, very little ability to raise taxes locally, rising costs, no capital funds to use alternate fuels technology, and air quality problems we are caught in a situation that will have disastrous results in the near future.

Without increased federal aid, cities will not be able to respond to air quality programs with mass transit as a partial solution. What the transit industry needs to help reduce air pollution is relaxation of the EPA standards until 1994, increased federal capital and operating funds for expansion and a re-thinking of the role of mass transit and automobiles in our lives with more incentives to use mass transit rather than the private auto. If we are successful by implementing the above actions then we can reduce air pollution while encouraging economic growth and a future for life on our planet.

APTA Petition to the
United States Environmental Protection Agency
for Rulemaking to Modify the 1991 Particulate
Emission Standards for Urban Transit Buses

SUMMARY

The American Public Transit Association ("APTA") petitions the Administrator of the United States Environmental Protection Agency for rulemaking under Section 202 of the Clean Air Act, 42 U.S.C. § 7521 (1982). Based on its analysis of recently obtained information, APTA seeks a rulemaking to modify the 1991 particulate emissions standards set forth in heavy-duty diesel engine regulations that apply to urban transit buses to hold bus engines to the same standards that apply to other heavy-duty diesel engines.[1] Such modifications are needed to achieve the maximum feasible reductions in urban diesel particulate emissions in the most cost-effective way possible.

New information submitted in reopened proceedings will show that if the EPA applies its 0.25 g/bhp-hr interim particulate standard uniformly to heavy-duty diesel engines, greater emissions reductions will be attained than would be possible under the existing 1991 standard for urban buses. Accordingly, EPA should do so. Further, APTA submits that even greater reductions in particulate emissions can be attained through a comprehensive particulate emission reduction program, as described in Part III of this petition.

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[1] The standards themselves were promulgated as final regulations on March 15, 1985. 40 C.F.R. §§ 86.091-11, 86.094-11 (1987).

APTA shares the EPA's commitment to improving urban air quality. Because APTA and its members have repeatedly advocated the use and expansion of public transit as a means of improving urban air quality through the reduction of motor vehicle emissions, APTA urges the EPA to consider the far greater and more immediate benefits that would be achieved through the alternative strategies discussed in this petition. APTA believes that the maximum amount of real progress will come as a result of a cooperative program involving EPA, the Urban Mass Transportation Administration ("UMTA"), vehicle and engine manufacturers, mass transit system operators, and APTA. Indeed, EPA and others recognize the importance of expanding urban mass transit services as a means of improving air quality.[2]

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[2] See, e.g., EPA Approval and Promulgation of Implementaion Plans, Transportation and Land Use Control Measures, 36 Fed. Reg. 30626, 30628-30 (1973); Blueprint for the Environment. Advice to the President-Elect from America's Environmental Community 13 (Nov. 1988).

Buses and bus service are an essential component of pollution reduction strategies.

APTA is an international organization representing local mass transit systems. Its members include over 300 American public and private mass transit systems, which carry over 95 percent of the persons using public transit in the United States. In addition, APTA's membership includes over 430 manufacturers, consultants, academic institutions and government agencies involved in the mass transit industry. This broad and diverse membership has enabled APTA to become the nationwide repository of information about public mass transit system operations, planning, trends and projections. APTA's members operate approximately 52,630 diesel engine buses.

The regulations subject to this petition establish an ultimate standard for heavy-duty diesel engine particulate emissions of 0.1 gram per brake horsepower-hour ("g/bhp-hr"). Heavy-duty diesel engines used in trucks are required to meet this standard beginning in model year 1994, and will be held to a transitional standard of 0.25 g/bhp-hr beginning in 1991. Where heavy-duty diesel engines are intended for use in urban buses, however, these engines are required to meet the 0.1 g/bhp-hr final standard in 1991, three years earlier than heavy-duty truck engines. The visible difference in emissions between these engines is negligible: the exhaust from both 0.1 g/bhp-hr and 0.25 g/bhp-hr buses will be clear.

The nature of the bus procurement process adds an additional note of urgency to these issues. The process of complying with federal and local regulations and the hurdles generally involved in vehicle procurement have in the past imposed an average lead time of 36 weeks on the procurement timeline. Currently, this period of delay between contract formation and actual delivery is 52 weeks, and there are indications that it is still growing. These figures mean that operators will need to enter into contracts with vehicle manufacturers by April 1990 for 1991 buses. In order to allow these operators time to issue specifications for their bus needs, to receive and review bids and to enter into contracts with vehicle manufacturers, workable emission standards must be achieved no later than July 1989.

Based on recent surveys of its members and other new evidence, APTA's analysis shows that retaining the special 1991 urban bus standard will adversely affect progress toward the reduction of particulate emissions during the 1991 - 1994 time period and beyond. It is now evident that if the 1991 bus standard remains unchanged, manufacturers will not be able to provide diesel-fueled buses during the 1991 - 1993 time period.

Further, in part because of the substantial system-wide costs, only a limited number of alternative fuel vehicles will be purchased. Transit systems will instead defer purchases of new buses until 1994, when it is expected that complying diesel engines will be available. As a result, few low-emission buses will be put into service, and far fewer older buses will be retired and replaced. The proportion of total urban bus vehicle miles travelled ("VMTs") by older, high-emission buses will grow, resulting in little reduction in total particulate emissions, if not an actual increase. In addition, a three year hiatus in the purchase of diesel-fueled buses would have a devastating effect on the domestic bus manufacturing industry and would constitute a constraint on expanding, or even maintaining, existing mass transit service levels.

On the other hand, the new information received by APTA shows that the engine and bus manufacturers using diesel fuel with reduced sulphur content and other engine modifications expect to meet the 1991 and 1994 particulate emissions standards applicable to heavy-duty diesel truck engines. Adoption of these standards would enable transit systems to purchase buses with the lowest feasible particulate emissions and, as shown in Part III below, would increase the proportion of fleet-wide VMTs attributable to low emission buses, resulting in greater overall reductions in particulate emissions.

Moreover, a cost-effective alternative strategy can be designed to reduce total particulate emissions even further. This strategy builds upon the benefits obtained from the procurement of buses that meet the achievable 0.25 g/bhp-hr interim 1991 standard and the 0.1 g/bhp-hr 1994 standard. The strategy further envisions: (1) increased use of low-sulphur diesel fuel in existing fleets to the maximum possible extent production facilities will allow; (2) expanded field development programs for alternative fuel and particulate-trap equipped vehicles and vehicle systems targeted for urban areas with the greatest particulate problems; (3) initiation of a study to assess the cost effectiveness of design modifications to reduce emissions from existing vehicles; and (4) an APTA-sponsored program involving engine and bus manufacturers and transit systems to provide intensive maintenance and engine adjustment training to reduce particulate emissions levels from the existing fleet to the maximum extent possible.

As demonstrated below in Part III, this alternative strategy would result in far greater total particulate emission reductions over the 1991 - 1993 time period than would be achieved by retaining the unattainable 1991 urban bus standard. These reductions have the additional virtues of being far more cost effective and less disruptive to the transit industry and the public it serves. In addition, this combined strategy affords flexibility to tailor emissions reduction programs to meet local needs by concentrating expensive and varied pollution control technologies on the specific areas of greatest need for each.

APTA's analysis and the new information provided in Part I show that the original assumptions underlying adoption of the technology-forcing 1991 diesel bus standard are no longer valid, and, according to recent statements by EPA officials, apparently have been abandoned. In their place, a new, untested rationale has emerged. The rationale is that transit systems can acquire alternative fuel vehicles during the 1991 - 1994 time period. This assumption is severely flawed and has not been subject to public comment and full analysis, including cost-benefit analysis.

Part II discusses the system of technologies necessary for the operation of alternative fuel vehicles. APTA fully supports the expanded development of these technologies; however, alternative fuel systems have not yet attained the degree of reliability and durability that transit systems require to place them in regular service outside the field development context. Alternative fuel engines have not yet been proven capable of meeting the applicable emission standards over the requisite 290,000 mile "useful life" period. Moreover, the additional costs of fuel, fueling stations, redesigned buses and the network of new support systems necessary to put alternative fuel vehicles into service place them out of the reach of most transit systems, particularly the smaller ones, as APTA's new survey information shows. Since diesel fuel buses meeting EPA standards are expected to be available in 1994, most transit systems could not responsibly incur the substantial capital costs of supporting a few alternative fuel buses to satisfy their procurement needs over the three year period. Instead, they will stockpile pre-1991 buses and defer the remaining purchases until 1994.

Since the assumptions underlying the feasibility of the 1991 urban bus standard have changed dramatically since 1985, and the standard now can be attained only by the procurement of alternative fuel vehicles of unproven reliability and at substantial additional costs, the EPA cannot rely upon these technologies in support of the 1991 standard without further analysis and public comment. That analysis must include a comparison of the extraordinary costs of meeting the interim standard with the minimal benefits in the small reduction of urban particulate emissions that would be achieved in the 1991 - 1994 time period. Such an analysis is essential to the EPA's statutory obligation to consider the "cost of compliance" and presents an independent and compelling reason for the EPA to reopen the record to reconsider the 1991 urban bus standard.

As explained in Part I below, reopening the record also will show that the assumptions made in 1985 underlying the decision to establish a separate, tougher particulate standard for urban buses have now proved incorrect in several essential respects. For example, it was assumed that the development of trap oxidizer technology for buses was simpler and more cost-effective than for trucks, when in reality the opposite has since proved to be the case. Subsequent experience has demonstrated that a separate standard for urban buses is counterproductive.

Based on the best available current information on the relevant technologies and on the procurement plans of its members, APTA is convinced that greater particulate emission reductions can be achieved by modifying the 1991 urban bus standard so that it matches the 0.25 g/bhp-hr heavy-duty diesel standard. APTA accordingly petitions the EPA to initiate a rulemaking to consider substantial new information that will allow the development of a truly cost-effective strategy to reduce urban particulate emissions to the maximum feasible extent during the 1991 - 1994 time period and beyond. In this way, real progress can be made toward the shared goal of cleaner air in urban communities.

Senator BINGAMAN. Thank you very much.

I just have a couple of questions here. I will start with Ron Sheck and ask if you could explain, briefly, what the problem is; why has Albuquerque been so unable to entice people to use mass transit as compared to other cites? You mentioned El Paso and Tucson and Denver. As I understood your testimony, in El Paso and Tucson there is about twice as much usage per capita, per inhabitant, and in the case of Denver it is, what, five times as much?

Dr. SHECK. Yes, Senator Bingaman, it is. I think where the transit has been successful in other communities, it has been successful because there is a strong local commitment to making that a key component transportation element in the community. I think maybe we have just not gotten there yet. I think we have great opportunities. I think it is a local decision. I know we at the state stand ready to help the city move in that direction.

Senator BINGAMAN. Is it a money issue? I mean do we need more money in mass transit here in Albuquerque in order for this to actually happen, or are you saying we can use the money we have and have a greater commitment to it and greater public awareness and through that increasing usage?

Dr. SHECK. I think we need more money on the capital side obviously if there is to be significant expansion, and bear in mind Albuquerque has operated basically the same public transit network it did in the 1970's. We have not seen any expansion into the suburbs, whereas we have seen that kind of expansion in Tucson in particular. You have people here who do not ride mass transit in New Mexico.

I spent my high school and college age years in California at a time when public transit was really falling apart. I go back out there today and I can get virtually anyplace in the State, from Palm Springs and Palm Desert and 49 Palms in the south to Eureka in the north. There are more people that ride public transit every day in Los Angeles than who live in the State of New Mexico, 1.7 transit riders in Los Angeles. It happens in California, and it happens in Iowa, and it happens in small cities in Montana, and it happens in Utah. I do not see why it cannot happen here if we make a commtment to make it happen.

Senator BINGAMAN. Naydne, do you have a point of view on this.

Ms. BICKNELL. Sure do. Again, it is a complex problem, partly caused by inexpensive cars and fuel, and the fact that Albuquerque has something like 1.7 cars per household. So both wage earners in most homes have cars. It is easy. It is a lot faster to drive your own car if it is availabile. It takes half as long. Some of the data we got from the uptown, the first part of the uptown study, I was talking about—in uptown we had set a goal years ago to try to capture 10 percent of the work trips. We are at 2 percent, even if that much at all. That is another part of our problem. We have diffused population. We do not have massive suburbs and downtown like other big cities do where people are going back and forth.

Our most successful bus routes are the ones that go to Sandia and to the university. But we do not have those population nodes, and this is part of what we are trying to look at in uptown to see if we can capitalize on where we do have more work trips concentrating and see if we can do better.

We need a lot of innovative transit planning. I do not think it is just a matter of throwing money at the problem. Some of these other factors have to be addressed in order to get people out of their cars and onto the buses.

Dr. SHECK. Can I comment on that?

Senator BINGAMAN. Sure.

Dr. SHECK. I think it is extremely important to get the private sector involved, and the program that U.S. West has, for example, to encourage its employees to use mass transit is really a very innovative step in the right direction, and the kind of thing employers in other parts of the country have done very successfully, subsidized passes, subscription bus services, et cetera.

Senator BINGAMAN. Yes, Mr. Peterson.

Mr. PETERSON. I have a background in city planning, so it kind of gives me a broader perspective than most transit managers. What I see happening in a lot of cities is conflicting goals. They are increasing the number of parking spaces while at the same time trying to encourage mass transit usage. That cannot happen. Cities like Albuquerque need to start restricting their goals. Do not build any more parking spaces. If they have a business going up that is close to a transit route, restrict the number of parking spaces they need for businesses. And businesses would love that, because that means less development costs for them. Just require customers to come to them on the transit system.

These are a lot of things that can be done. Jack up the cost of parking in the downtown areas. This is another strategy that can help. There are a lot of different things that can increase mass transit usage, and primarily it has to do with the way mass transit is viewed in the community. If it has a good image, you will increase your ridership. I have in Las Cruses taken it from 400 rides a day up to 1,600 rides a day in three years, so there is no reason not to increase transit ridership in any city.

Senator BINGAMAN. Sounds to me like Yogi Berra's famous saying about how people do not want to come out to the ball park, who is going to stop them. If you do not provide parking places in the downtown area, people will not come there. I do not know that the result will be that folks will ride the bus to get downtown. It will be that folks will go somewhere else to do their shopping or conduct their business. I am afraid. I do not know.

Mr. PETERSON. We can prevent urban sprawl from occuring by limiting building licenses in the outlying areas. Urban sprawl is tremendous. It we have a concentrated effort, it will fall into line.

Senator BINGAMAN. Let me defer to Senator Domenici for questions.

Senator DOMENICI. We did not have the energy crisis when I was on the city council, and we surely had our headaches with trying to make a mass transit system work. Nobody wanted to use it. Nobody did use it. We subsidized it and advertised it.

On the other hand, let me ask you, Nadyne, is it not true that from the standpoint of promoting its availability, you have done nothing else, not all the other notions: Since you have been on the council during that period of time, you have tried to promote it as available and what its price is? Just that one issue.

Ms. BICKNELL. Yes.

Senator DOMENICI. So would you not agree that you are not going to talk people into it? Is that a fair statement?

Ms. BICKNELL. Yes.

Senator DOMENICI. It seems to me it is something else that is going to make them use it rather than for them to know it is there at this point. I regret to say I think it is going to get more used when the roads get more congested and that is if, in fact, they find that the alternative is more convenient. I hope as you look at master plans for transportation that you are looking at that eventuality. It seems to me to be a more realistic one than any of the others; that you would not want to be overcongested on regular automobile traffic and how do we mandate, tell people, ride mass transit if it is not quicker; if mass transit is in the same traffic jam. So it seems to me that is an issue that works in some of the major cities when they give them their free lane.

I would also say in the cities like Los Angeles and Washington, D.C. the ridership on the mass transit is up dramatically, but I have to tell you for the most part it is for some really rapid mass involvement. It is not neighborhood bus rides. It is to get from 16 miles out to downtown in something like a train or subway.

And it would appear to me that we could keep on talking about it here and in Las Cruces, but I cannot imagine that it is going to be a major, major component for quite some time; just because of the realities that you have explained, Nadyne. Obviously it would be a neat idea if anyone politically in the world can do it, to make automobiles even more expensive than they are, and then we all would be out of office, and we could turn it over to some other people. One of the notions you brought up was that cars and gasoline were too cheap. That is the reason I brought it up.

Let me just close, Mr. Chairman, by thanking these witnesses and all of them. To those that have been involved in mass transit, to the extent that we use it in New Mexico and work with it, personally it has been a pleasure helping. I think we have some opportunities, even though they differ from the big cities, to do some innovative things and exciting things. We ought to continue to help you.

To you, Nadyne, every time I hear you talk about local government, I regret for the people of this city that you have elected to go into retirement from this work at such a vibrant age. [Applause.]

I would also say, Mr. Chairman, one of the neatest things I got to do is to ask in 1975 that she be appointed to that prestigious commission that we heard from, our first witness, Dr. Fouts, the NIEHS. She served on that. I think she served the entire length of time allowed by law, and they made her stay on as a consultant for free because they liked you so much.

Ms. BICKNELL. Thank you.

Senator DOMENICI. Thank you, Mr. Chairman.

Senator BINGAMAN. Thank you.

I want to thank this group of witnesses and all the other witnesses who have given testimony today. I think this information and recommendations that we received will help us greatly in deliberations that we have in the Senate on the reauthorization of the Clean Air Act.

The hearing record for the subcommittee will remain open for two weeks for additional statements. If anybody wants to submit a statement, please send it to my office here in Albuquerque or my office in Washington or Senate Energy and Natural Resources Committee in Washington D.C.

I also want to thank the energy committee staff for their assistance in putting on this hearing. Patty Beneke, Lisa Vehmas, Wanda Freeman and Richard Grundy are all here from our Washington staff, and they have done an excellent job.

I invite all of you in the audience and all the witnesses, of course, to join Pete and myself for lunch down at the end of the hall here. We appreciate your attendance at this hearing.

Senator **DOMENICI**. Could I thank you? I just want to thank you for having the hearings, and it is a pleasure to be with you. I think they will contribute to the evolution of the Clean Air Act and the Acid Rain Deposition Act in Washington. We can use what we have learned, and I thank you for that.

Senator **BINGAMAN**. Thank you very much.

[Whereupon, at 12:15 p.m. the hearing was adjourned.]

APPENDIX

Additional Material Submitted for the Record

UNIVERSITY of DENVER
Colorado Seminary

Department of Chemistry

June 2, 1989

The Honorable Jeff Bingaman,
U.S. Senate,
525, Hart Senate Office Building,
Washington DC 20510

Dear Senator Bingaman

Thank you for the opportunity to present written testimony to the May 25th, 1989 hearing of the Mineral Resources Development and Production Subcommittee of the Senate Energy and Natural Resources Committee, held in Albuquerque New Mexico. Enclosed are my comments, please add them to the committee's record. If you would like any additional information on effective means to reduce air pollution from motor vehicles, please call me.

Yours sincerely,

Donald Ste

Donald H. Stedman
Brainerd Phillipson Professor of Chemistry
(303) 871-3530

Encls EST, ANAL CHEM, SAE

DHS:mjj

University Park, Denver, Colorado 80208 303•871-2436

UNIVERSITY OF DENVER

WRITTEN TESTIMONY

submitted to the May 25th, 1989 hearing of the Mineral Resources Development and Production Subcommittee of the Senate Energy and Natural Resources Committee

My name is Donald Stedman. I am a professor of Atmospheric Chemistry at the University of Denver.

Oxygenated gasoline fuels for automobiles are widely heralded as "cleaner burning." These words should not be used without question since they are not always correct. There is a large body of vehicle test data which shows that rapidly switching the fuel from gasoline to gasohol (or other oxygenated fuels) on a normal fleet of cars will result in a reduction of average carbon monoxide (CO) emissions. The model used by EPA to predict fleet behavior from vehicle test data, however, includes one assumption which cannot be correct according to the laws of chemistry and leads to predictions that are biased too high. Oxygenated fuels reduce fleet CO emissions, but not as much as EPA predicts.

The same vehicle test data shows that emissions from new vehicles are insignificantly improved by so-called "cleaner burning" fuels. Only dirty cars are improved significantly by fuel oxygenation. Data show that these dirty cars can be improved in their CO emissions even more by a tune-up to manufacturers' original emission specifications.

The University of Denver has developed a remote sensor to detect these dirty cars as they drive along the road. With this tool we have measured the CO emissions from over 120,000 vehicles and we have shown in several locations that half the CO comes from about 10% of the vehicles. Half the CO from 10% of the vehicles, which we term "gross polluters", does not disagree with the State and Federal computer models. Our results from these on-road measurements do, however, disagree with conventional wisdom in several respects.

1) Gross polluters are not all old.

2) Gross polluters are not all owned by poor people.

3) Current Colorado inspection/maintenance programs do not reduce emissions as much as claimed.

4) Fleet turnover will not, in itself, provide cleaner air unless the average age decreases.

5) Tighter new-car standards will have an insignificant impact on cleaner air.

6) The key to cleaner air is to maintain the fleet at the current new-car performance.

A program of CO control based on remote sensing can reduce pollution more effectively and at lower cost than current programs. Three peer-reviewed publications describing remote sensing are included as appendices.

There may be reasons other than carbon monoxide control which can be used to justify oxygenated fuels mandates. The reasoning would no doubt take into account the demonstrated increase in NOx and aldehyde emissions. If this committee decides to support these mandates, then I strongly endorse the research program proposed by the Technical Advisory Group. There has been very little research on oxy-fuels which has been carried out by any agency independent of the mandate itself.

The EPA model for the effect of oxygenated fuels predicts a permanent reduction in CO. There is no evidence that the reduction is permanent. In fact, there is reason to believe that the reductions may only last a few months before the fleet is just as bad as ever despite the extra expenses associated with the continued use of those fuels.

It is important to carry out independent research to test the predictions of the currently-used models.

1) How much improvement in fleet emissions is achieved?

2) How long does the improvement in emissions last?

I strongly support the independent Oxy-Fuels Research Program suggested by the Technical Advisory Group.

There is an analogy between achieving cleaner air and achieving a successful cup of coffee. You can pour in the cream (oxy-fuels) first, then the coffee (cleaning up the dirty cars) or you can pour in the coffee first. If the coffee alone satisfies the customer then the job is done without adding the more expensive cream. In other words, identifying and cleaning up the dirty cars should be the first priority, the more expensive oxygenated fuels programs should follow only if necessary and justified.

Thank you for the opportunity to make this presentation.

NPGA
National PROPANE GAS Association
1235 Jefferson Davis Highway • Arlington, Virginia 22202 • 703/979-3560

May 23, 1989

Honorable Jeff Bingaman
United States Senate
625 Silver Ave., Sw, #130
Albuquerque, NM 87102

Dear Senator Bingaman:

On behalf of the National Propane Gas Association and the New Mexico Propane Gas Association enclosed are copies of our views on the clean air and alternative fuels legislation before Congress. We ask that you include these comments as a part of the record for your hearing on May 25th.

New Mexico has clean air problems like many states. We believe that propane or LP-gas can help reduce pollution from internal combustion engines, particularly from motor vehicles. In New Mexico the use of propane as part of a clean air program will support the local economy since New Mexico is a producer of LP-gas.

If you would like additional information on propane, clean air and motor fuels, please contact me at the Association's Washington office at 703/979-3560. In New Mexico our contact is Mr. Jim Ikard who serves on the Association's Board of Directors. Mr. Ikard is a propane marketer with seven locations in New Mexico; he can be contacted at 505/525-5611.

Thank you for considering our testimony and for your leadership on this issue.

Sincerely yours,

Jim Burroughs

James N. Burroughs
Vice President, Government
Relations and General Counsel

JNB/sb

NPGA
National PROPANE GAS Association
1235 Jefferson Davis Highway • Arlington, Virginia 22202 • 703/979-3560

May 23, 1989

Honorable Jeff Bingaman
U.S. Senate
625 Silver Ave., SW, #130
Albuquerque, NM 87102

Dear Senator Bingaman:

On behalf of the National Propane Gas Association and the New Mexico Propane Gas Association, I am pleased to submit testimony for this hearing on clean air in New Mexico. We applaud your efforts to resolve the air pollution problem at both the state and national levels.

The National Propane Gas Association (NPGA) is the trade association of the LP-gas industry representing over 4,000 members and 47 affiliated state associations. The membership is comprised of marketers, transporters, suppliers, equipment manufacturers and producers. Propane is the most widely used alternative motor fuel in the world today and NPGAs members are keenly interested in the subject of this hearing.

Almost 100 cities in this country are out of compliance with the mandates of the Clean Air Act, including Albuquerque. There is a great need for revision of this Act and need for states to take an active role in the clean air program.

LP-gas, primarily propane and butane, is derived from natural gas (about 68% of supply) and crude oil refining (about 32% of supply). Approximately 88% of supply is produced in the United States with 75% of the imports coming from Canada. It is therefore a very secure energy supply.

New Mexico is both a producer and user of LP-gas. Therefore any clean air program that includes LP-gas will bolster the state economy. In 1986, over 70 million gallon of propane and 382 thousand gallons of butane were consumed in the state not including use as a chemical feedstock. National consumption runs about 15 billion gallons per year with LP-gas providing about 4% of our nation's total energy.

Widely used in home heating, water heating, cooking, crop drying and other agricultural uses, LP-gas also fuels over a million motor vehicles including cars, trucks and industrial forklifts.

ALTERNATIVE FUEL STRATEGY

We believe that any clean air plan must include means for dealing with internal combustion engines. This includes all forms of motor vehicles, non-road vehicles, and stationary engines. Our cities need immediate help and we believe that LP-gas can play a key role in cleaning up our air. Among the many benefits of LP-gas use in both motor fuel and industrial applications are:

- Reduced emissions on vehicles having no or limited emission control devices;
- Reduced emissions on vehicles with emission control devices;
- A closed fuel system which eliminates evaporative emissions;
- No contamination of groundwater or water systems from either above or below ground storage tanks
- Long lasting emissions control devices due to the clean burning characteristics of this gaseous fuel;
- Reduced emissions from industrial boilers and process heaters currently using oil.

Attached to our statement are the results of emission tests of LP-gas powered vehicles conducted by EPA's labs in Ann Arbor, Michigan and Denver, Colorado. These tests show clearly and dramatically that a light duty Ford LTD passenger car's emissions can be reduced by converting to LP-gas. Using EPA data you'll note that this vehicle's gasoline hydrocarbon emissions were already 50% below the 1988 standards, 76% below the carbon monoxide standards and slightly higher on nitrogen oxides than the standard.

Despite the already clean emissions on gasoline, the hydrocarbon emissions when tested on propane were 73% below the standard and 50% below gasoline (using California Air Resources Board reactivity factors). The carbon monoxide was 93% below the standard and 70% better than gasoline and nitrogen oxides were 39% below the standard and 43% better than gasoline.

We believe that LP-gas is the perfect fuel for fleet users. It has proven ideal in metropolitan fleets by bakery companies, delivery trucks, transit and school buses and taxi fleets. However, many of these fleet vehicles have little or no emission control devices and converting to LP-gas can address that problem.

Local delivery vehicles, taxis and bus fleets are known for their periods of curbside idling during pick-up, stop-offs, discharging passengers, etc. It is during these times of idle and in stop-and-go of city traffic, that noxious emissions reach peak levels. We believe that LP-gas is the ideal solution for this vexing problem faced by all metropolitan areas.

Many light and medium duty fleet vehicles on our roads today still lack meaningful emissions controls. Since it will be 5-10 years, if then, before any substantial number of low-emission vehicles will be operating, legislation which facilitates retrofit of these older, high emitting vehicles to gaseous fuels (LP-gas and natural gas) only makes sense.

Senator Bingaman, you have been a leader in recognizing the problems associated with fleet vehicles. You introduced legislation in the last Congress, along with Rep. Fazio in the House of Representatives, to require the Federal government, the largest fleet operator in the country to convert its vehicles to alternative fuels. We supported that bill last year and will support it again when it is reintroduced.

Gaseous fuels (LP-gas and natural gas) are the only alternatives available now. And now is when we have a problem. If the mandates of the Clean Air Act are to be met, this country can't afford to wait for a solution to the supply problems and lack of compatible vehicles for alcohol based vehicles. Conversion of gasoline powered vehicles to propane is happening today all over the country.

REAL WORLD SCENARIO - THE IMPACT OF LP-GAS

Translating data into a real life situation brings focus to the impact LP-gas can have on the fleet market particularly for the non-attainment areas.

Statistics indicate that there is a total U.S. truck registration of almost 19 million. Of this number, approximately 8.5 million are in fleet use. As stated before, we believe that LP-gas and natural gas are particularly suited for that market characterized as fleets which return to a central base every night and which consist of vehicles that are five years old or less. We calculate this market to represent about 2.1 million trucks or 25% of the total U.S. fleet market.

School buses represent another prime market for propane use. School bus fleets from Florida to Oregon have been converted to propane. In this market, there are an estimated 352,434 school buses on which about $5.75 billion per year is spent by school districts nationwide. It has been proven that propane can cut costs, extend engine life and reduce maintenance on these vehicles. In addition, school districts have approximately 11,000 underground storage tanks susceptible to leaks compounding the problem of contaminated water.

Looking at the question of adequate supply, we estimate that an additional 4.0 billion gallons of U.S. produced supply will be available by 2004. Adding Canadian surplus production and only 50% of the other world-wide surplus production we calculate 8.0 billion gallons of additional supply will be available during the next 15 years. If we add the gas liquids planned for export from the Alaska North Slope the additional supply grows to 11.0 billion gallons. The scenario does not include any of the 5.3 billion gallons currently going into the chemical market simply because the price is cheap.

ALTERNATIVE FUEL OPTIMIZATION

We strongly endorse the concept of optimization of the various fuel alternatives for those applications best suited. For example, an extensive infra-structure is already in place to service the private automobile market with gasoline. To duplicate that system for the sole purpose of having alternative fuel is neither cost-effective nor necessary. By looking to the conversion of fleet vehicles the necessary transition can be accomplished with a minimum of disruption and will allow for the development of an infrastructure along with public acceptance of alternative fuels.

The average fleet vehicle travels more miles than a private automobile, consumes two-and-half to three times the volume of fuel, and employs less sophisticated emission control devices which greatly reduce air quality. For this market, central fueling locations for propane are cost effective.

Realistically, LP-gas is not the panacea to the U.S. air pollution problem. No singular fuel is. Supply simply would not be adequate. We see the following scenario:

- Gasoline, oxygenated fuels and methanol for private vehicles;

- Diesel in areas without attainment problems;

- Gaseous fuels (LP and natural gas) for fleets and inner city markets.

With the current major investment in diesel-powered equipment now in place in those areas, some type of incentive or mandate will most likely be required to move fleet operators away from diesel and on to gaseous fuels such as propane.

This concept has been proposed in Rep. Michael Andrews bill that gives tax credits as incentives to aid in the conversion of vehicles to alternative fuels and to help develop alternative fuels infrastructure.

Methanol may be the fuel best suited for the general public over the long pull. But until the problems are resolved the benefits are currently elusive and speculative. Until the benefits of methanol can be experienced the gaseous fuels can be - if nothing else - a transitional fuel because it's here now. Should other fuels or sources of energy claim a rightful role later on, so be it.

CONCLUSION

We think that there are several means for the efficient use of LP-gas as an alternative fuel, specifically:

- Elimination of the federal excise tax of 9 cents per gallon on LP-gas. At a minimum a reduction to a BTU parity with that of gasoline.
- Special incentives to van pool operators using LP-gas or other low-emitting fuel.
- Making petroleum violation escrow funds available through the state to support state incentive plans.
- Stipulating specifically "LP-gas" in the definition of alternative fuels legislation.

By allowing a wide variety of choices in reaching that goal, the market is encouraged to respond. We believe that will result in lower compliance costs, faster response time, and greater public acceptance. If you set a standard and keep the market open, we believe that LP-gas will thrive and play a key role in cutting air pollution.

We appreciate your willingness to consider our views and look forward to working with you in the future.

Sincerely yours,

James N Burroughs

James N. Burroughs
Vice President, Government
Relations and General Counsel

JNB/sb

EMISSION TEST RESULTS

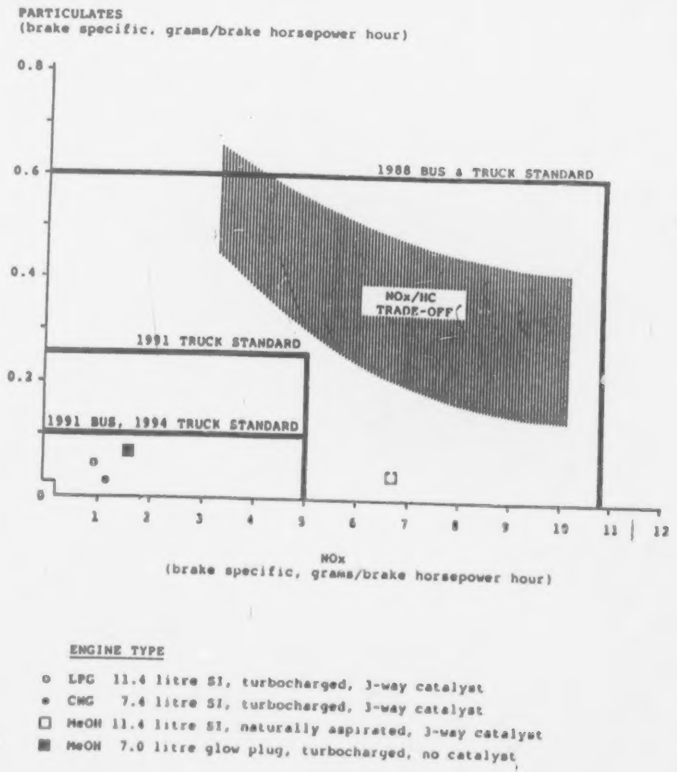
PETROLANE 1988 FORD CROWN VICTORIA (T.N.)

TEST SITE: ENVIRONMENTAL PROTECTION AGENCY (EPA) ANN ARBOR, MI.

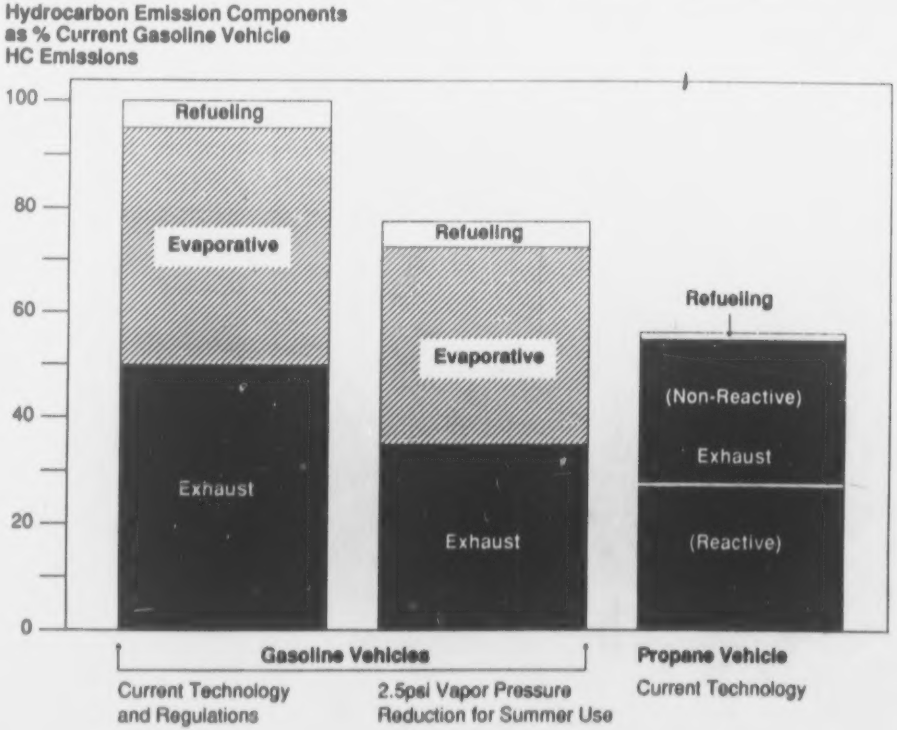
	THC TOTAL HYDROCARBONS		CO CARBON MONOXIDE	NOx NITROGEN OXIDES
GASOLINE STANDARD* GM/MI	.41		3.40	.70
GASOLINE BASELINE (INDOLENE)	.22		.79	.75
	GROSS	NET		
COMMERCIAL PROPANE (LPG)	.26	.11	.24	.43
% BELOW STANDARD	37%	73%	93%	39%
%BELOW GASOLINE	(18%)	50%	70%	43%

* 1988 FEDERAL STANDARD AND ALTERNATE CALIFORNIA STANDARD

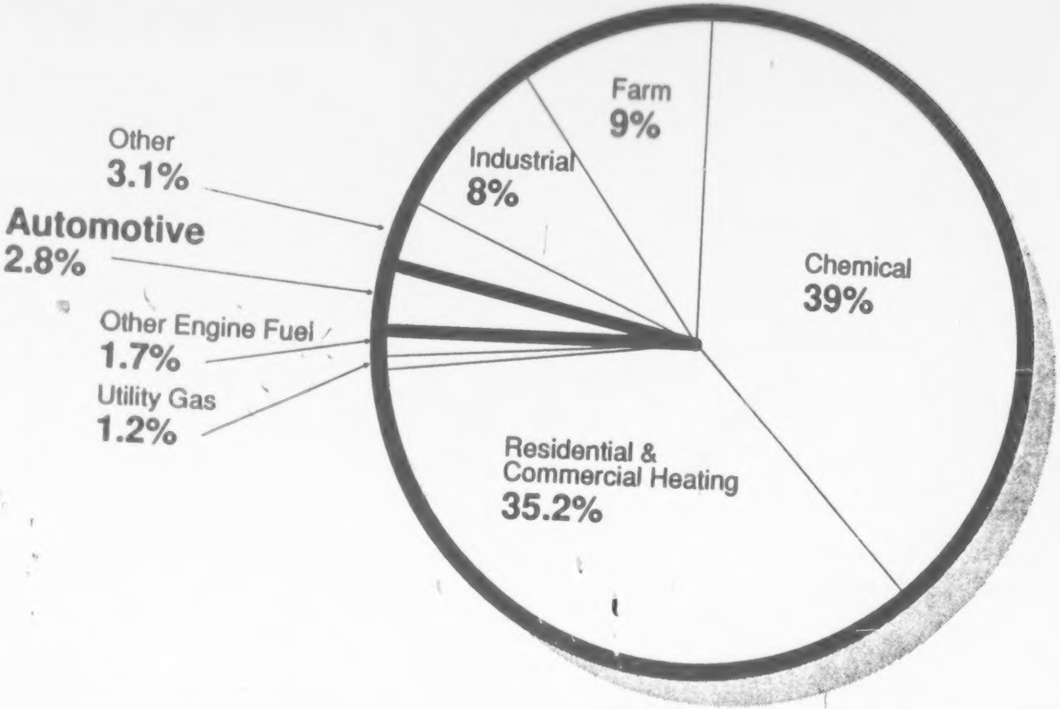
Truck & Bus Engine Emission Control: 1988 Status



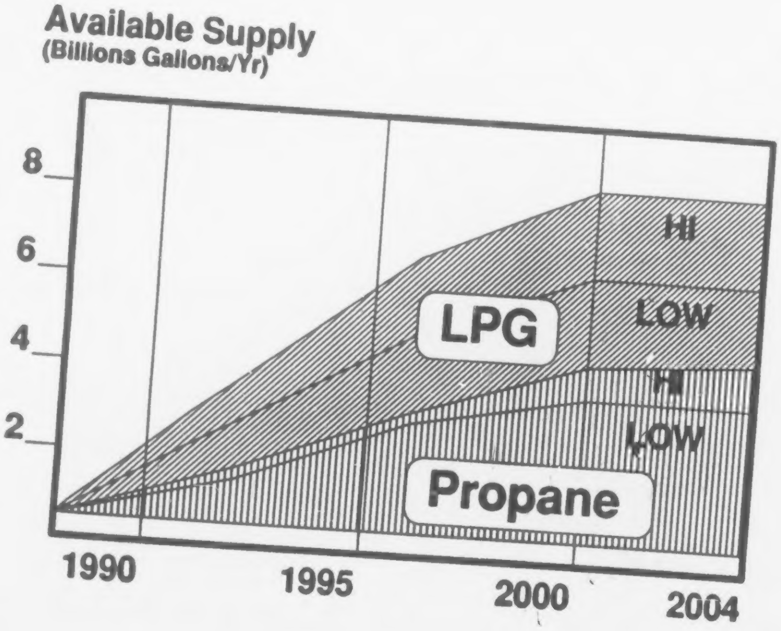
Propane as a Strategy for Vehicle Emission Control



Merchant Market Sales of LPG in the U.S. 1987

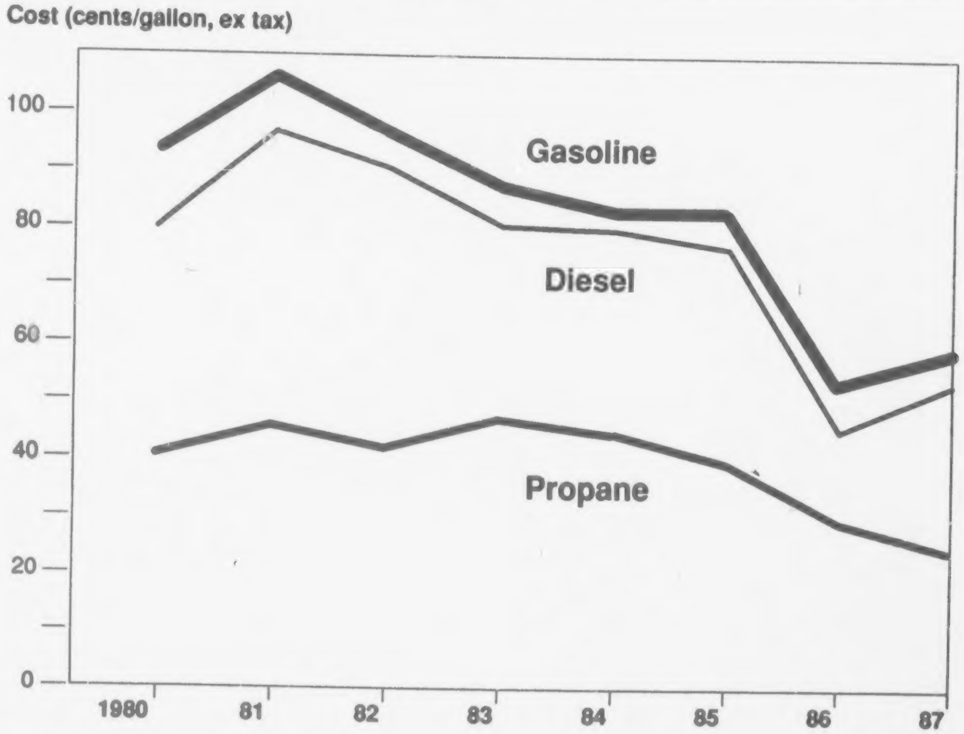


U.S. Auto - LPG Supply & Potential Vehicle Population



2004	
Vehicles (Millions)	Fuel (%)
6.5	5.4%
5.2	4.2%
3.6	3.0%
2.9	2.4%
0.33	0.4%

Wholesale Fuel Cost Trends 1980 - 87



Statement of
The Association of Commerce & Industry of New Mexico

to

Senate Field Hearing
Clean Air Summit
Albuquerque, New Mexico

May 25, 1989

The Association of Commerce & Industry of New Mexico (ACI) is a statewide association of individuals, businesses and organizations established to promote programs conducive to the orderly growth and economic development of the State of New Mexico and its business community.

Among the many business organizations we work closely with on national level is the Clean Air Working Group (CAWG). ACI serves as CAWG's state contact in New Mexico working toward improvements in air quality that are balanced between environmental needs and a competitive business economy.

The Association of Commerce & Industry of New Mexico is concerned that proposals now before Congress to change the Clean Air Act could impose severe and unnecessary financial burdens on businesses and consumers in New Mexico. There are legislative proposals now under consideration that would dramatically expand current environmental laws and impose a cost to business nationally of billions of dollars without the evaluation necessary to determine the environmental and economic impacts on human life.

▬ Acid Rain

Specifically, environmental activists are supporting an acid rain bill (H.R. 1470) that calls for extensive installation of costly but outdated scrubbers. It is estimated that this bill alone would cost consumers, nationally, an additional $5 billion a year in electricity bills, in addition to higher automobile costs and lessened fuel efficiency.

Another acid bill is H.R. 144 that represents a considerable improvement over H.R. 1470. H.R. 144 recognizes the need to use improved clean coal technology instead of outdated scrubbers for reducing smokestack emissions. However, the reduction levels and deadlines specified in both bills are considered highly unrealistic.

▬ Smog

The only bill we are aware of specifically addressing smog or ozone non-attainment is H.R. 99. We applaud the bill's provisions that recognize the importance of cost-effectiveness in assessing emission control programs. We also agree with H.R. 99 and its recognition that further reduction of oxides of nitrogen, as called for in the acid rain bills, may actually increase ozone levels in some areas. We do, however, believe it necessary that H.R. 99 be amended to provide more time for planning and for reaching the attainment goals. In addition, we believe individual states should have more authority in developing emission reduction plans.

▬ Air Toxics

There are two air toxics bills now under Congressional consideration. H.R. 4 and S. 816 both intend to strengthen control of toxic or hazardous emissions. However, S. 816 calls for emission reductions for a list of nearly 200 pollutants at a cost of billions of dollars to be spent on "maximum achievable control technology". This could threaten the survival of thousands of businesses from neighborhood gas stations and dry cleaners to citrus growers. We would urge our New Mexico Senators Domenici and Bingaman to not cosponsor or support S. 816.

ACI is especially concerned that these and other proposals ignore the air quality improvements that have already taken place in New Mexico. In recent years major New Mexico industries have made substantial investments in air quality control equipment at their facilities.

Examples include: The Phelps Dodge Smelter in Hidalgo county was constructed at a cost of $300 million. One third of that cost or $100 million was devoted to pollution control equipment. Arizona Public Service has invested approximately $470 million in pollution control equipment since 1981 at its Four Corners Power Plant. The Public Service Company of New Mexico has some $645 million in pollution control equipment at its San Juan Plant. The Giant Refinery outside of Gallup has over $1.2 million in air quality control equipment and is not even under any sanctions or mandates to install such equipment. The Chino Mines Smelter modernization was completed at a cost of $130 million with $55 million of that total devoted to pollution control.

These industry investments represent substantial bottom line expenditures to those businesses that translate into higher product and service costs to consumers. The proposals now under Congressional review could increase those bottom line costs significantly for businesses and certainly hold the potential for employment reductions and higher costs to consumers.

ACI and all New Mexicans want clean air. But the facts in this state show that important strides in air quality improvement have been made. It concerns us that Congress may enact sweeping national requirements that ignore the progress our state has made. Such an effort would put New Mexico in the position of paying the bill for some problems of the heavy manufacturing areas in the East and on the west coast.

The impact of these proposals is not limited to large industry. If enacted many of our state's small businesses could be forced to cut emissions dramatically or face stiff penalties.

This is not to say that ACI opposes any additional air pollution controls. Clearly, actions need to be taken to solve our remaining air pollution problems. But, any future control plans should be based on a clear understanding of our remaining air quality problems and require controls which deliver real environmental benefits at a reasonable cost.

STATEMENT OF DR. MICHAEL WILLIAMS
FOR THE FIELD HEARING
OF THE SUBCOMMITTEE ON MINERAL RESOURCES DEVELOPMENT
OF THE US SENATE ENERGY COMMITTEE

I thank Senator Bingaman and the other subcommittee members for giving us this opportunity to express our views on the issues of long-range visibility and air quality in the scenic Southwest. This statement is prepared on behalf of New Mexico Citizens for Clean Air and Water. I have attached a brief description of my background to this testimony.

I would like to begin my discussion with some history of the regulation of visibility in New Mexico and on the national scene. I will highlight some of the major shortcomings of the state and federal efforts to protect visibility.

Concern about effects of pollutants on visibility has long been the driving force for much of the air pollution control activities of environmental groups in the west. I doubt if New Mexico Citizens for Clean and Water would have ever been formed if many of us had not seen portions of the Sangre de Cristos disappear in to the haze. For those that argued that the federal standards protected against all possible effects, the rejoinder that the federal standards would permit visibility to diminish to 12 miles was usually an overwhelming response. The same position caused our group to grow rapidly. It also inspired a rewriting of our state laws to explicitly empower the agency to protect visibility and witnesses for the NMEID were among the first to produce respectable visibility modeling in the context of a regulatory hearing. The same arguments lead to a growing concern over the direction of the federal air programs throughout the west. Environmentalists from the west joined with eastern interests who were concerned about the export of jobs to rural areas to push for prevention of significant deterioration. New Mexico was part of the original suit which forced the federal program to move toward prevention of significant deterioration. New Mexicans were instrumental in the work toward adoption of a specific provision in the law to prevent significant deterioration. When the EPA proposed a definition of PSD which was solely tied to ground level concentrations of some of the criteria pollutants, New Mexicans were quick to point out to members of congress that major visibility questions would not be addressed by such an approach.

In the senate the adverse affect on air quality related values was the response to these concerns while in the house Rafe Pomerance pushed for a specific provision on visibility. He was able to convince Congressman Rogers that it was most inappropriate for visitors to National Parks to be presented with brown or gray smears across the sky or landscape. When the hearings on the visibility provision came up in the house a New Mexican, myself, presented what I believe was the only technical testimony in support of the provision. Eventually the provision passed and was agreed to by the senate and became part of the Clean Air Act Amendments of 1977.

There were two major aspects to concern over visibility in national parks: one was the prevention of the kind of hazes we have seen in the Rio Grande Valley and the second was the prevention of impairment of vistas from places like Bryce Canyon National Park by brown plumes associated with sources like large powerplants. In the lobbying and testifying the point was not that the plumes would actually be in the park, but that they would impair the visitors experience as he tried to enjoy park vistas. The specific example cited was the proposed Kaiparowits plant plume as seen from vistas in Bryce Canyon. The viewpoints were only a few kilometers from the park boundary and they were directed outward from the park. In this context a plume within the park boundaries would actually be less apparent than would one just outside the park boundaries because the more distant plume would have much sharper boundaries and would stand out more from its background.

For those of us who were active in producing the legislation, the concept of integral vistas, although we didn't call it that, was one of two keystones. Without integral vistas much of the point of the legislation would be lost. The other keystone, regional haze is still not being regulated. Thus both of the driving concerns for the legislation have not been implemented. Without integral vistas the visibility provisions of the federal law are severely limited and don't address the important questions for places like Bryce Canyon or Mesa Verde. Effectively, visibility protection has been withdrawn from all but the largest parks or wilderness areas which have major vistas totally within their perimeters. For these reasons the state and federal visibility regulations have had little effect to date.

Visibility is still a major concern in the west. Studies have indicated that visibility damage can amount to billions of dollars a year in western parks. Consumer surveys by in-state utilities have indicated a willingness of New Mexicans to pay to prevent visibility impairment. It is ironic that between Donald Hodel's "leave to the states" policy and the legislatures strictures against standards stricter than the federal government; New Mexico's visibility program is falling through the cracks. I would hope that new Clean Air legislation will remedy these problems and provide real protection for visibility.

I would now like to discuss the important challenges to visibility protection programs. The first challenge is posed by the pollutant NO2. NO2 has long been known for its effect on visibility. NO2 absorbs shorter wavelengths in the visible portion of the spectrum with the result that a white target may appear brown or yellow when viewed through NO2 gas. In addition to its direct effects, NO2, under appropriate conditions, also converts to particulate nitrates which scatter light effectively.

One of the most straightforward instances of NO2 visibility impairment occurred near Carmel, California. The nearby Moss Landing Power Plant produced a very striking brown plume which caused a considerable uproar by local residents. The plant burned natural gas and occasionally oil, particulate emissions were very low, but NOx emissions were very high. The plume at stack top was invisible, but it quickly converted to a striking red-brown plume. The utility worked aggressively to control NOx formation in the boiler and they were able to drop NOx concentrations in the exhaust gases from 1300 ppm to 75 ppm with a dramatic reduction in the plume discoloration. Ambient concentrations of NO2 were generally rather low even during the worst of the plumes because the bulk of the material was trapped aloft in stable air.

Nearer to home I have observed a brown plume from the San Juan plant even though only unit 1 was operating. The controls added to the Four Corners plant traded a gray plume for a brown one. However, the trade was still positive because the particulate emissions before cleanup not only discolored the sky but they also obscurred terrain features. NO2 plumes are primarily obvious when viewed against a blue sky or another relatively bright background such as a snowfield. The Nitrates produced from NO2 are a different matter, they can obscure dark colored terrain as well as bright skies.

NO2 can also impair visibility in urban areas. The Denver brown hazes have been the subject of a number of studies (Russell, 1973). My group at Los Alamos was once employed to examine the role of NO2 in the Denver brown haze. We have developed a technique which allows us to produce a simulated picture which illustrates the effects of increasing pollutants in a scene. We applied the technique to see what role the NO2 was playing in the Denver haze.

We began by taking a clean picture of the Rio Grande valley from a point near Los Alamos. We then simulated the effects on the scene of a haze similar to that found in Denver. We prepared pictures with NO2 at 0.109ppm and examined what would happen if the NO2 were doubled or reduced by a factor of four. The results showed that changing the NO2 changed the pictures noticeably as long as you were not looking toward the sun. The pictures simulating conditions with the observer looking toward the sun showed less effect of NO2 because particulate matter scattered more light into the observer's view and masked the effects of NO2.
Analyis of the measurements taken at the station closest to downtown Denver indicated that that the fraction of light extinction due to NO2 was .4,.35,.25, and .11 for wavelengths of 4000,4500,5000, and 5500 Angstroms respectively. The measurements were taken during a severe brown haze episode on Nov. 21, 1973.

I have referenced a document which describes studies during the brown haze episodes of late 1973. The front cover shows a yellowish haze over Denver, while the inside back cover shows a dark brown haze over Denver. Both pictures were taken during the brown haze episode of 11/21/1973 but the front cover picture is toward the sun while the back cover is away from the sun. The average NO2 concentrations on the day in question are 0.101ppm. For comparison New Mexico ambient stardards list 0.10ppm of NO2 as the dividing line between acceptable and unacceptable air quality for a 24 hour period, while the federal standards provide even less protection with an annual level of .05ppm.

The Denver brown hazes are dramatic and exceptionally ugly. Levels of NO2 permitted by the New Mexico 24 hour standard play a significant role in these hazes. In addition to the NO2 the nitrates produced from NO2 also play a significant role in the visibility impairment. In later measurements (Wolff, et al.,1981) nitrates accounted for 20% of the average fine particle mass during the brown haze season. Nitrate concentrations reached almost 60 micrograms per cubic meter for one four-hour period.

Particulate matter tends to mask some of the effects of the light absorption by NO2. For this reason I have carried out a calculation of what the effects of NO2 alone might be on the color of a distant snowfield. I assumed that 0.10 ppm of NO2 was between the observer and a snow field 50 kilometers distant. I picked a low sun angle characteristic of late fall or early winter conditions. The result was that the snow would appear yellow-orange rather than white and that there would be a marked contrast between snow behind the NO2 and snow above the NO2. In this instance the difference between the unobscurred snow and the obscurred snow is approximately twenty times the perception threshold.

Some people tend to look on visibility as unimportant, however careful studies have reached quite the opposite conclusion. Studies (Schulze, at al., 1981) where people were asked what they would be willing to pay to prevent visibility impairment in western National Parks have produced yearly estimated amounts in the billions of dollars. Large scale hazes were considered more important than sky discoloration by plumes, but both plumes and hazes were important. The estimate of the benefit associated with avoiding plumes over the Grand Canyon amounted to 2.04 billion dollars per year. The response of people to the Moss Landing plume supports the findings of the studies. Nearer to home PNM has surveyed its customers and asked if they would be willing to pay more to keep the skies blue. Again the response was positive.

Our state law mentions visibility explicitly because our citizens stressed its importance to our legislators. We don't like skies with ugly smears across them or cities which disappear in the murky air.

In addition to effects on visibility NOx emissions also pose a threat to our forests and lakes and streams. These effects include endangering the heatlth of our forests and acidifying lakes and streams. The best documenting case of acid rain effects in the rockies is associated with poor reproduction of tiger salamanders described by Professor John Harte near Gothic, Colorado. I expect that this work and other work on NOx effects will be described in more detail by Bob Yuhnke, so I will not develop it in my statement.

If we are to avoid these problems we must effectively control NOx emissions. Fortunately NOx control technology has advanced significantly since the San Juan station was built. For example in the context of a permit for a new oil shale facility EPA region VIII recently ruled that tailgas cleanup of NOX was available technology. Furthermore staff for the California Air Resource Board (State of California - Air Resources Board, 1981) concluded that 80% control of NOx emissions from new coal-fired power plants was both technically and economically available. The CARB guidelines assumed that NOx emissions could be held to less than 0.09lbs/mmBTU for units operating at over 50% capacity. The staff concluded that NOx controls would cost $42 to 66/kw installed with levelized costs of 4.4 to 6.5mills/kwh. They estimated somewhat higher costs for SO2 controls.

Recently other techniques have been developed which might also reach levels of control comparable to the CARB recommendation. Okigami (Okigami, 1985) reports on a three stage combustion technique which produces exhaust gas concentrations of 100-150 ppm of NOx. Investigators with RocketDyne (Dykun, 1985) report on a new burner which achieves 100 ppm NOx exhaust gas concentrations which the investigators think could reach levels of 50 ppm in the exhaust gases. Murakami (Murakami, 1985) reports that the Mitsubishi Advanced Combustion Technology can reach levels between 50 and 150 ppm in the exhaust gases.

Other investigators (Lowell et al., 1985 and Hooper et al., 1985) report significant NOx control with sodium based additives in conjunction with fabric filters. Most recently, the cool-water coal-gasification, powerplant of Southern California Edison has demonstrated much better NOx controls. It achieved emission levels of about .05lbs/mmBTU which are about half the CARB standard. It appears that at least one good NOx control technology has been proven and several others are nearly ready.

Two other important visibility related pollutants are fly ash and sulfur dioxide. I doubt I need dwell on the impacts of fly ash on visibility for this audience. The changes in the sky since effective controls were added probably suffice to make the argument far better than anything I could say. Those same changes testify to the effectiveness of modern particulate control technology.

Sulfur dioxide emissions play a somewhat more subtle role. Sulfur dioxide like nitric oxide is invisible. However sulfur dioxide slowly converts to fine particulate sulfate. Sulfates are associated with visibility degradation throughout the nation. For example we found that visibility at Bandelier National Monument and Chaco Canyon significantly improved when the smelters in southern Arizona were shutdown during a strike.

Two other authors and I once used the results of the bidding game investigations into the value of visibility to calculate the dollar damages per pound of sulfur dioxide emitted into the southwestern environment. We arrived at a value of $13. per pound sulfur dioxide emitted. The highest control costs we had were about $1.50 per pound. On the basis of visibility we are not yet controlling sulfur dioxide at levels high enough to achieve a cost benefit ratio of one.

In urban areas there are other major sources of visibility impairment. The single biggest part of the transportation component of visibility impairment results from emissions of diesel powered vehicles. Buses and trucks were left to EPA to regulate in the Clean Air Act Amendments, unfortunately EPA's controls have not been as effective as the controls mandated for new automobiles in the act.

Another major concern is the oxidant precursors released by the automobile fleet. Hydrocarbons and NOx form oxidants which speed the conversion of sulfur oxides into visible sulfates. Oxidant forming potential is greater at the higher altitudes of the mountain west. Furthermore the controls which are placed on new vehicles are less effective at the altitudes in the west. There are two major problems which must be addressed. First, we have nearly outstripped the effects of the controls mandated for new vehicles as our vehicles miles have increased. Second, the maintenance and efficiencies of the control equipment are inadequate at higher elevations. We must expect, that without major improvements in controls on new vehicles, that emissions of hydrocarbons and NOx will begin to grow. Furthermore, without more attention to the effects of higher altitudes, the situation will be relatively worse for the high altitudes in the west.
The west suffers doubly because it experiences high growth rates and suffers the lower efficiencies associated with higher altitudes.

There are other major components of western air quality deterioration which also deserve attention such as the emissions of wood burning stoves or fireplaces. However, while I think they are important problems which should be addressed, I will leave them to those who have studied them more than I have.

I hope that the new legislation can do a better job than the old legislation did. Among the features which I think a new act should have are: (1) regional caps on NOx and SOx emissions, (2) a provision for protection of integral vistas, (3) mandated new vehicle controls for diesel powered vehicles, and (4) mandated tougher new vehicle emission standards which require efficiencies to be maintained at high levels as vehicles age and also be achieved at high altitudes and with cold temperatures.

I consider that you have a very important task before you and I hope my comments will be useful to you.

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Mike Williams
Rt 5, Box 229A
Santa Fe, N. M. 87501

Background of Michael D. Williams

For over 20 years, Mike Williams has been active in New Mexico environmental affairs. He is a leader and co-founder of New Mexico Citizens for Clean Air and Water and a former chairman of the Sierra Club's Southwest Regional Conservation Committee. The principal focus of these activities originally was the control of sulfur oxide and particulate emissions from southwestern powerplants and smelters. He was a member of New Mexico's first Environmental Quality Council and a member of the New Mexico Ground Water Quality Advisory Committee. He has also served on a number of other committees such as the National Air Quality Commission's Panel on Air Dispersion, the Air Quality Task Force of the National Coal Policy Project, the Risk/Impact Panel of the National Research Council's Committee on Nuclear and Alternative Systems, and the Sierra Club's Air Quality Committee and the Sierra Clubs Energy Committee.

For the last 19 years most of his professional work has dealt with the construction and testing of models for describing the transport and dispersion of air pollutants. He has also developed models for prediction of visibility effects of air emissions. He is currently a staff member at Los Alamos National Laboratory; he has also served as research coordinator for the John Muir Institute for Environmental Studies, and has consulted for several state and federal agencies and environmental and citizen groups.

He holds B.S., M.S. and Ph. D. degrees granted by UCLA's College of Engineering.

Testimony

before the

Senate Committee on Energy and

Natural Resources

Presented by

Ben G. Henneke, Jr.

President

Energy Fuels Development Corporation

Mr. Chairman, I'm pleased for the opportunity to appear before you today to discuss the importance of alternative fuels, especially renewable liquid transportation fuels, and the surprising improvements in the cost of production and the economic competitiveness of those fuels.

I am President of Energy Fuels Development Corporation, an ethanol manufacturer in Eastern New Mexico. Our production facility was built in 1985 and commenced production at the end of that year. At the time of construction it was a highly energy efficient, highly integrated facility and the subsequent, substantial improvements that have been made in the process and in the mechanical operation of the plant have meant that the plant is now capable of running in excess of 130% of its capacity. Additional engineering and expansion work is expected to bring the plant to 150% capacity, or approximately 15 million gallons per year.

These expansions without enormous capital costs are important because they show that a similar new plant could be rated at higher capacity for approximately the same capital cost as our plant. This means the capital costs of producing ethanol from grain have been declining for the last five years.

As you look at the entire fuel picture in the United States, four things are obvious:

- We are heavily dependent on uncertain foreign oil for our transportation fuels

- The use of those fuels has caused substantial and endemic air pollution problems throughout our nation

- More fuel efficient and cleaner burning cars have not been able to reverse our dependence on foreign oil or clean up our air

- There is no obvious alternative to the use of liquid transportation fuels in the foreseeable future

One less obvious trend which has compounded our environmental problems in the last decade is that refiners both here and abroad made changes in their manufacturing processes to extract more gasoline from barrels of higher sulfur and lower quality crude oil. Unfortunately these changes had the effect of increasing the air pollution when those fuels were burned. For instance, higher volatility has increased both unburned hydrocarbon emissions during refueling and during operations, and carbon monoxide emissions during operations. Increased levels of aromatics have raised levels of carcinogenic benzene and other air toxics to substantially higher levels than would have been the case from gasoline manufactured before the 1973 Arab oil embargo or the refining changes.

Alternative fuels: natural gas, ethanol, methanol, and the ethers made from those alcohols (MTBE and ETBE) can directly address both the obvious problems with our liquid transportation situation and can improve the quality of fuel both from a performance and environmental stand-point. I would like to look at these alternatives in a slightly different division than is usually made. First, I would like to look at the alternatives as local area specific air pollution strategies, and then second, I would like to look at the alternatives as a national strategy to improve energy security, improve the global warming problem, and dramatically reduce pollution.

First, let's review the alternatives as a local area air quality strategy. Conversion of vehicles to operate on natural gas is both inexpensive and cost-effective. Because compressed natural gas automobiles require that they have special tanks and refueling, natural gas is most appropriate for fleet use at the present time. However, inadequate incentives have been offered to induce cities to convert their bus fleets and taxicabs, and private companies to convert the majority of their vehicles. The federal government has not converted their fleets either. Natural gas combustion is one of the cleanest forms of mobile source combustion and has an enormous benefit in reducing ozone precursor emissions.

The use of ethanol or methanol either "neat" which means almost entirely alcohol or as a blend is an extremely powerful strategy if adopted enthusiastically by fuel manufacturers. All of the oxygenates - ethanol, methanol, MTBE and ETBE have much higher octane than any of the all hydrocarbon-octane choices such as toluene, benzene, etc. Higher octane holds the key for improved performance for automobiles and air quality all at a lower cost.

Usually, high octane components in gasoline also turn out to be the most reactive ozone precursors and the most difficult for automobile manufacturers to design materials and systems to operate properly. Let me give you a few examples: the olefins and diolefins made in refining and attractive because of their octane have been found to create the port fuel injector fouling problems that plagued the automobile and fuel industries just three years ago. The aromatics - benzene, toluene and xylene are known mutagens and carcinogens and also have strong solvent effects on rubber parts in vehicles. These kinds of impacts have largely been ignored by the fuel manufacturing industry because "aromatics have always been in gasoline", and little attention was paid as the percentage of aromatics rose from less than ten to over thirty percent average in the gasoline pool. Aromatics have octane numbers only around 100 where the alcohols are 112 to 115 and the ethers 106 to 110. Thus the alcohols and the ethers which do not produce similar levels of carcinogenic compounds and do not have any identified injector fouling problems can be rapidly substituted for the lower octane, dirtier burning aromatics and olefins. Research has shown that the solvent properties of the ethers and alcohols are not, at the concentrations necessary for blends, any more of a real world problem than the solvent properties of the aromatics.

What about costs? All of the oxygenates are cheaper than all of the aromatics. In other words, an aggressively, enthusiastically embraced strategy by refiners could substitute cleaner burning, higher octane, less expensive oxygenates for the environmental and public health risk of aromatics; the result would be improved automobile performance and an improved environment with a lower direct cost to consumers and lower health costs as well.

This is so obvious a strategy and so enormously beneficial to our country that it is surprising that the progress of refining and marketing companies to adopt such a strategy has been so slow. Perhaps the vertical integration which allowed refineries to purchase their own crude oil and the very high profits in crude oil production, refining and marketing the last 10 years has slowed this process.

There are, however, signs of hope. The largest producer of MTBE, Arco, is actively discussing reformulating the gasolines to improve their environmental impact and their performance, and that same company is choosing to use ethanol in their stations during the Phoenix 1989-90 wintertime program. The Environmental Protection Agency has at long last issued their volatility reduction requirement for summertime gasoline in the United States which begins to take street gasoline back closer to the quality that it was 15 years ago and eventually will take it back to the quality that is used to certify the vehicles to ensure that they are low polluting.

Let's look at cost again because too often misinformation about cost has been provided to policy makers in an effort to slow down the acceptance of alternative fuels. I would like to focus on ethanol where I am most familiar with our detailed costs.

Ethanol for years has had the reputation of being more expensive than regular gasoline. This is not true. When apples are compared to apples ethanol production is less expensive. Let me illustrate this in two simple ways:

1. Imagine a program for domestic oil producers that was the equivalent of our federal program for domestic grain producers. In other words, we would have a system whereby domestically produced oil could be sold on the open market or could be sold to the government through a loan and forfeiture program at much higher than market price. This problem would increase the market cost of domestic crude to domestic refiners to the point that they would raise gasoline prices. If such an equivalent program were enacted ethanol costs on the open market without subsidies would match gasoline costs.

2. It's even better than that. Today, even with a policy of supported grain prices (raw material for ethanol), and a policy of keeping crude prices as low as possible through military intervention as necessary in the volatile middle east, the cost for aromatics in the open market even with cheap crude is much higher than the cost of ethanol. So, ethanol's real

competition, the aromatics fraction of gasoline, is more expensive, more polluting, and has an alternative high value market in plastics production.

It is very clear to me that ethanol is competitive with other alternatives. Only the market constraints due to the enormous power of the existing liquid fuel producers, refiners and marketers have kept these alternative fuels from making a more substantial impact on the market. For four years ethanol has been lower cost, and has experienced no growth, while higher cost octane additives have boomed. Unfortunately increased ownership of marketing and refining assets here in the United States by foreign oil interests is not encouraging for the voluntary "free market" acceptance of lower cost domestically produced renewable and clean burning ethanol.

Now, I would like to turn your attention to the use of the alternatives as a way to improve the global climate and our energy security. First, natural gas releases less carbon in the atmosphere and therefore creates less global warming carbon loading than any of the hydrocarbon alternatives. Domestic gas production has still not been fully exploited due to the long-standing, low comparative price that natural gas has received compared to crude oil or refined products. Increasing natural gas demand will increase exploration in the lower 48 and can dramatically improve the amount of emissions from transportation and electric generation sources.

Ethanol and methanol, or the ethers derived from these alcohols by reaction with isobutylene, can have an even greater impact on global warming. Both ethanol and methanol can be made from grains, wood-waste, cotton gin trash and many other biologically-derived sources. The carbon in the alcohols comes from carbon, not underground, but from carbon in the air — carbon which is captured by the growing plants or trees and fixed into the plant structure as part of its natural growth cycle. Thus, when renewable ethanol or methanol is burned, it is releasing carbon that less than a year ago was in the atmosphere. It is a closed-loop recycling of atmospheric carbon, not a release of additional carbon.

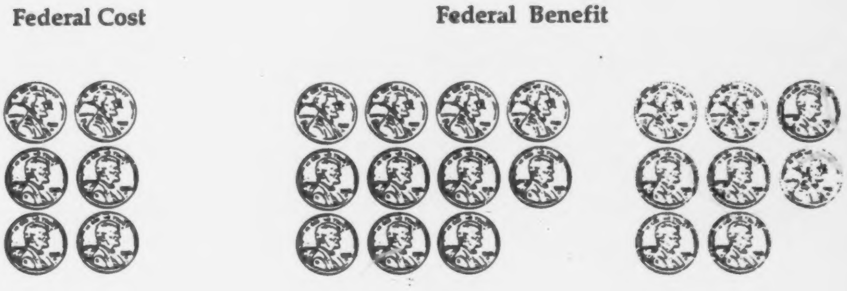
There are two offsetting factors to this closed loop. First, hydrocarbon derived fuels are used to produce the grains and woods and to transport the biomass to the manufacturing plants and also to fuel, provide heat and electricity at the manufacturing plants. The amount of fossil fuel necessary to operate one of these plants and to grow the crops has been declining very dramatically in the past decades. Farming practices with reduced fertilizer and fuel use are rapidly spreading and improving. Also, ethanol plants, at least, have gone from requiring more fossil fuel to produce a gallon of ethanol to requiring much less than half the btu's found in the product to produce that product. Ethanol production is now the most efficient way to turn natural gas, coal, or nuclear-generated electricity into a clean burning liquid transportation fuel.

Second, if as part of the improved farming practices some of the stalks and refuse from the crops are tilled back into the earth, the carbon captured from the air is then returned to the earth and the farming process becomes a true "carbon sink". Properly managed, the farming carbon sink can offset all of the carbon released from the production of the ethanol fuel and truly create a zero carbon release system.

I have provided you with a few charts which graphically demonstrate the beneficial economics and the beneficial environmental impact of using these alternative fuels. I'll be happy to answer any questions you or your staff have.

HOW DOES THE TAXPAYER BENEFIT FROM ETHANOL'S FEDERAL TAX INCENTIVES?

The White House Task Force on Regulatory Relief has issued the most recent analysis on the cost/benefit of the Federal incentives. The Task Force found that the 6 cent per gallon tax credit for ethanol resulted in benefits to the Federal government of between 11 cents and 19 cents per gallon. (And they did not include ethanol's air pollution benefits, jobs benefits, octane benefits, and national security benefits.)



HOW DOES THE PUBLIC BENEFIT FROM ETHANOL'S NEW MEXICO TAX EXEMPTION?

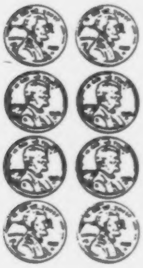
The 8 cent per gallon New Mexico ethanol exemption results in more than 8 cents of benefit to New Mexico:

As shown earlier, 10 cents goes to New Mexico motorists when they buy ethanol: a better product at a lower price.

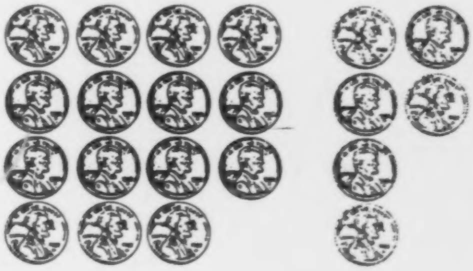
Additional benefits go to:

- New Mexico residents, in reduced air pollution control costs.
- New Mexico residents, in reduced medical and welfare costs.
- New Mexico farmers, in the form of higher grain prices.
- New Mexico dairy and cattle feeders, in the form of reduced feed costs.
- New Mexico refineries and gasoline retailers in the form of marketing discounts.

New Mexico Cost



New Mexico Benefit



MOVING BEYOND THE MYTHS.

It's time for
a national
ethanol
policy.

1979 Myths

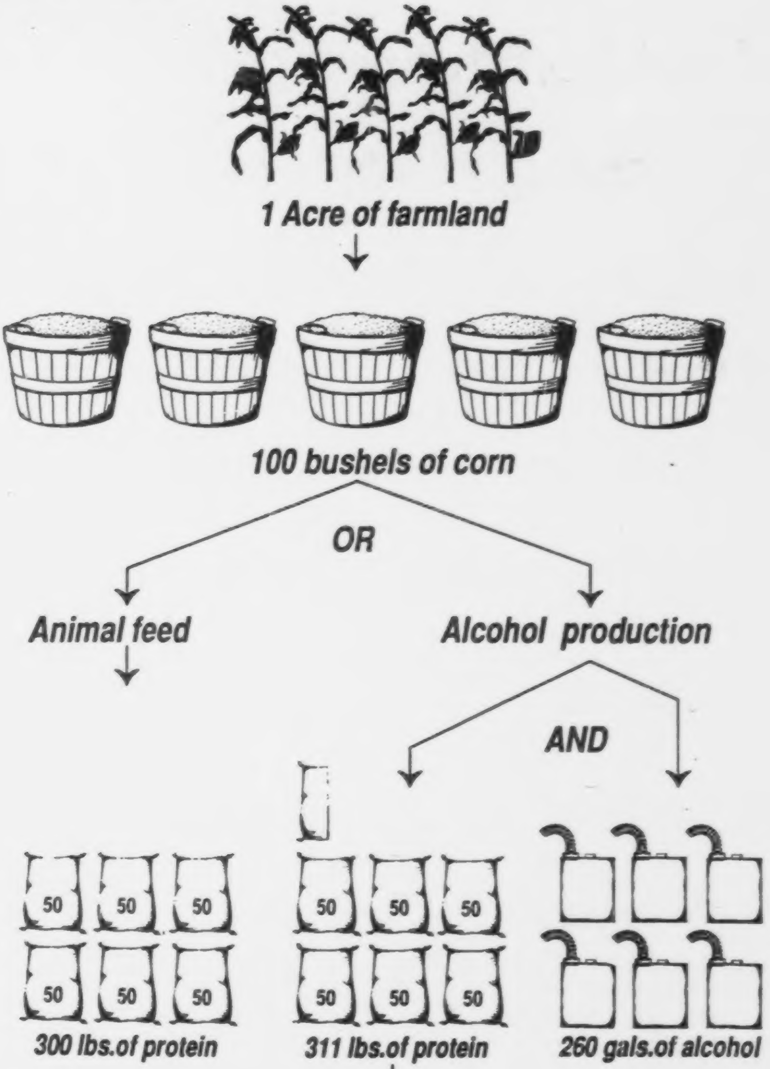
- ☐ *"Ethanol converts scarce food to fuel."*
- ☐ *"Ethanol's not energy efficient."*
- ☐ *"Your car won't like it."*
- ☐ *"Cars don't need more octane."*
- ☐ *"Ethanol can't go in pipelines."*
- ☐ *"Cleaner cars + I/M = clean air by 1987."*
- ☐ *"Ethanol creates ozone."*
- ☐ *"Gasoline's all the same."*
- ☐ *"ETHANOL'S NOT ECONOMIC."*

1979 Myth: "Converts scarce food to fuel."

1989 Reality:

- ☐ *World shortage is of protein, not grain carbohydrates.*
- ☐ *Ethanol production increases protein.*
- ☐ *Ethanol production increases bypass protein dramatically.*

Food vs. Fuel


1 Acre of farmland
100 bushels of corn
OR
Animal feed
Alcohol production
AND
50
300 lbs.of protein
311 lbs.of protein
260 gals.of alcohol

High Bypass protein means DDGS produces more meat or milk.

1979 Myth: "Not energy efficient."

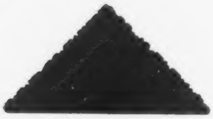
1989 Reality:

- ☐ Ethanol is energy efficient.
- ☐ 10 years of technical progress.
- ☐ Greater heat efficiencies.
- ☐ More rapid fermentations.
- ☐ Painfully acquired engineering expertise.
- ☐ Transferable operations techniques.
- ☐ Small plants can be efficient.
- ☐ Energy Fuels Dev. Corp. uses 39,000 BTU's to produce 78,000 BTU's of ethanol.

It's actually better than that:

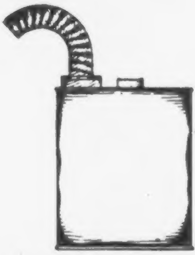
Ethanol is the SYNFUEL of today.

- ***Ethanol is the most efficient way to convert coal or natural gas to liquid transportation fuel.***

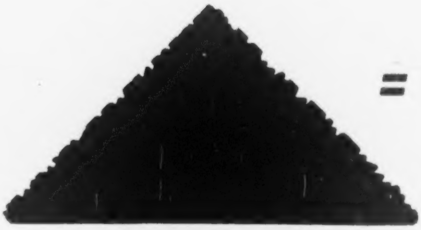


2.5 lbs of coal
30,000 BTU'S

=



6.3 lbs. of ethanol
78,000 BTU'S



20 lbs. of coal
240,000 of BTU'S

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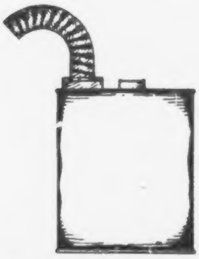
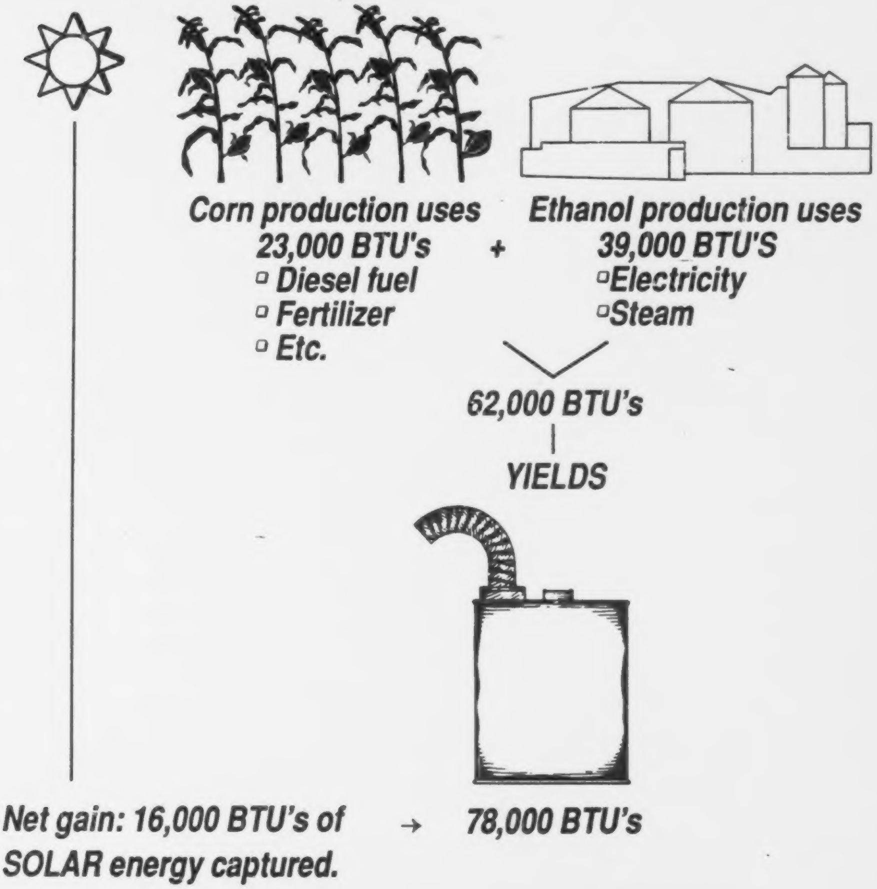


6.3 lbs. of SynGas
120,000 BTU's

In fact, it's even better than that:

Ethanol is the only SOLAR liquid transportation fuel.


Corn production uses
23,000 BTU's
▫ Diesel fuel
▫ Fertilizer
▫ Etc.
+
Ethanol production uses
39,000 BTU'S
▫Electricity
▫Steam
62,000 BTU's
YIELDS
Net gain: 16,000 BTU's of SOLAR energy captured.
→
78,000 BTU's

Ethanol is the only fuel that CREATES usable energy.

1979 Myth: "Your car won't like it."

1989 Reality:

- ☐ ***All cars don't like toluene.***
- ☐ ***All cars don't like gas residues and gums.***
- ☐ ***G.M. and Chrysler PFI cars don't like olefins.***
- ☐ ***BMW's don't like most detergents.***
- ☐ ***Ethanol is cleaner than any high octane alternative.***
- ☐ ***No problems in 10 years and 600,000,000,000 miles.***
- ☐ ***Newest tests show ethanol performs better than gasoline.***

G.M. now recommends alcohol fuels.

1979 Myth: "Cars don't need more octane."

1989 Reality:

- ☐ "Octane quality" of regular unleaded has declined.
- ☐ Higher mileage cars need more octane.
- ☐ Knock-sensor cars can benefit from higher octane.
- ☐ Fastest growing consumer segments are higher octane unleadeds even at substantial price premiums.

1979 Myth: "Ethanol can't go in pipelines."

1989 Reality: Refiners control pipelines.

- ☐ Still using 1950's sloppy housekeeping techniques.
- ☐ Contaminated water (hazardous waste) still in pipelines.
- ☐ Refiners won't allow ethanol in pipelines.
- ☐ Pipeline test shipments of alcohol all successful.
  - ☐ Williams Pipeline
  - ☐ ARCO

Keeping ethanol out of pipelines provides a LARGE competitive advantage to petroleum refineries.

1979 Myth: "Cleaner cars + I/M = clean air by 1987."

1989 Reality:

- ☐ Cleaner cars have made a big difference.
- ☐ I/M less effective than hoped.
- ☐ Cars not designed to handle high aromatic, high volatility gasoline.
- ☐ 104,000,000 people live in non-attainment areas.
- ☐ Present predictions show little hope from only "cleaner cars + I/M."

1979 Myth: “Ethanol creates ozone.”

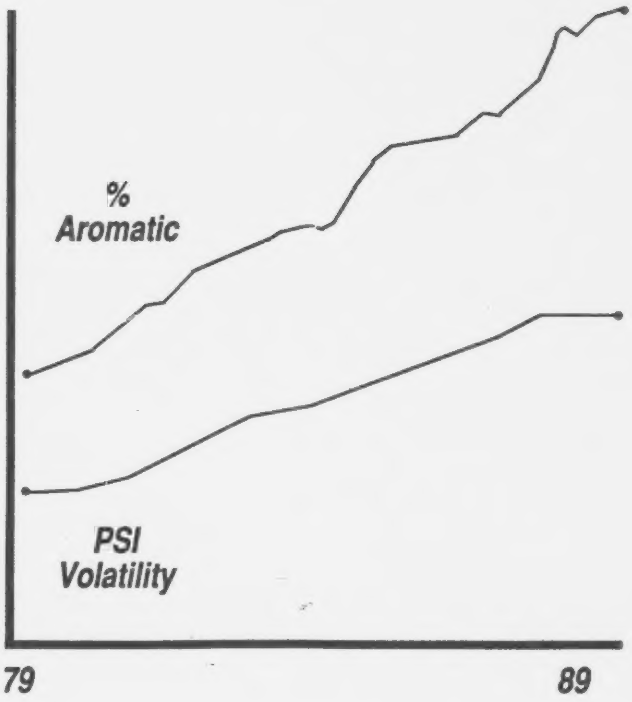
1989 Reality:

- Ethanol replaces 10% of gasoline.
- Ethanol is less reactive than the gasoline it replaces.
- Ethanol can substitute for extremely reactive gasoline constituents like xylene, benzene, toluene, diolefins.
- Properly formulated gasoline with ethanol reduces ozone 12%-20%.
- Ethanol reduces “greenhouse” gases 10%-50%.
- Ethanol reduces carbon dioxide production 25%-50%.

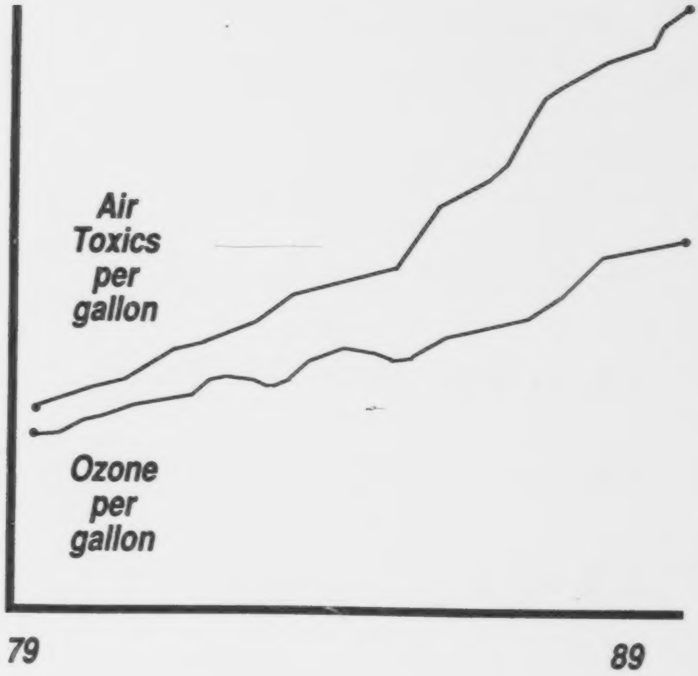
1979 Myth: "Gasoline's all the same."

1989 Reality:

- Refiners have changed gasoline dramatically.



So today, gasoline is much worse for our health:



1979 Myth: "ETHANOL'S NOT ECONOMIC."

1989 Reality:

Marketplace does not allow ethanol to get its:

☐ Octane value.

☐ Clean air value.

☐ National security value.

☐ Balance of trade value.

☐ Renewable fuel value.

Why doesn't ethanol receive its full value?

Is it surprising the largest industry in the world would strongly resist losing 10% of its high profit sales?

The measure of the oil companies' market and political strength is the difference between ethanol's true value and its current market price.

WHAT'S WRONG?

Market prices tell economic truth when:

- ☐ There are many buyers and sellers.
- ☐ Buyers and sellers have equal power.
- ☐ Standardized product.
- ☐ No externalities.

Gasoline/Ethanol prices lie, because:

- ☐ ***Few buyers have enormous power***
    - ☐ ***Own refineries***
    - ☐ ***Own pipelines***
    - ☐ ***Own retail stations***
    - ☐ ***Own brand identification***

- ☐ ***Discriminatory labeling misleads.***

- ☐ ***Pollution, national security ignored.***

To find the economic truth, you must compare apples to apples.

(Real national costs are full costs.)

New Domestic Gasoline (87 Octane)		***PER GAL***
New crude finding/production costs		*$ .63 - 1.02*
New refinery cost		*.35*
Revenues from other products		*(.14 - .23)*
MARKET COSTS		*.84 - 1.14*
Ignored costs		
CO	*.05 - .10*	
HC	*.03 - .07*	
Particulates	*.01 - .04*	
Air toxics	*? - ?*	
Present value of domestic crude reserves	*.09 - .21*	
IGNORED COSTS		*.18 - .42*
TOTAL TRUE COSTS		*1.02 - 1.56*

1989 Reality

- ☐ ***No new oil fields***
- ☐ ***No new refineries***

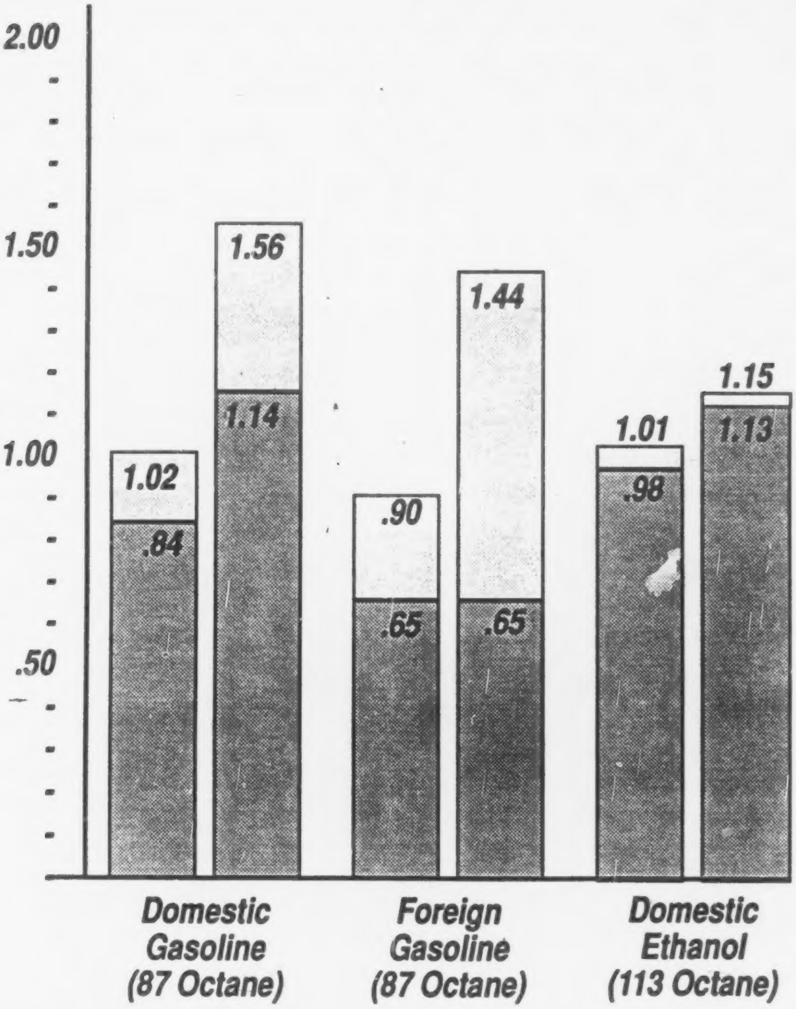
So, now supplies are imports.

New Foreign Gasoline (87 Octane)		*PER GAL*
Market price of foreign product		*$ .65*
Ignored costs		
Health costs	*.09 - .21*	
Present value of crude	*.03 - .14*	
Trade deficit cost	*.01 - .04*	
DOD "National Interest" cost	*.12 - .40*	
IGNORED COSTS		*.25 - .79*
TOTAL TRUE COSTS		*.90 - 1.44*

New Domestic Ethanol (113 Octane)		PER GAL
Corn cost		$ .62 - 1.04
New plant cost		.75 - .88
Revenue from other products		(.36 - .79)
MARKET COSTS		1.01 - 1.13
Ignored costs/benefits		
CO	(.06 - .11)	
HC	.02 - .09	
Particulates	(.01 - .03)	
Air toxics	? - ?	
Present value of fossil energy needed to produce corn and ethanol	.02 -. 07	
IGNORED COSTS		(.03) - .02
TOTAL TRUE COSTS		.98 - 1.15

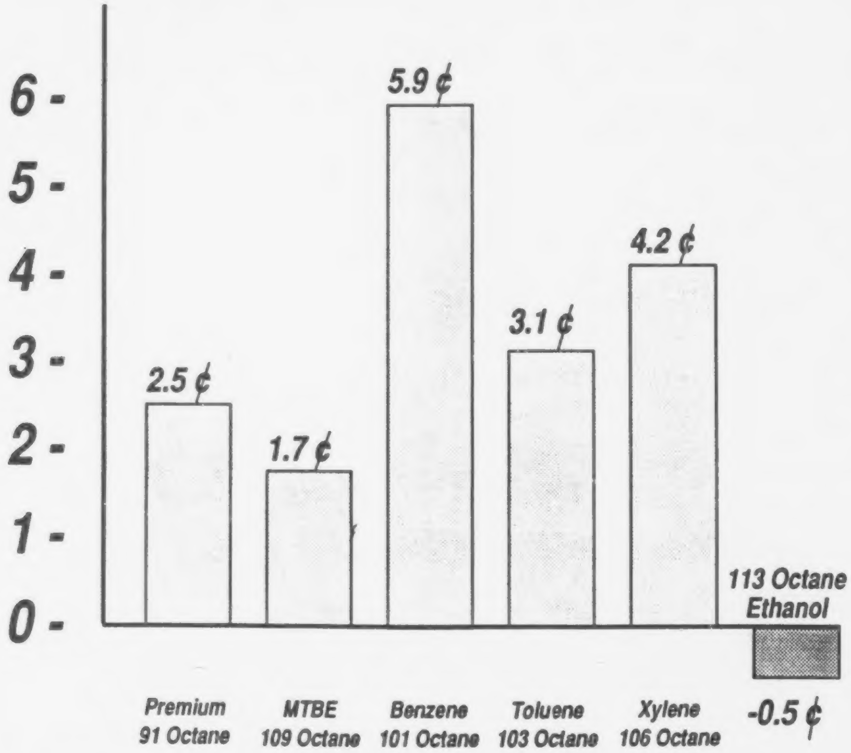
So, apples to apples, a gallon of 87-octane foreign gasoline actually costs society up to 25% more than a gallon of 113-octane domestic ethanol.

And these economics don't include ethanol's increased rural jobs, reduced farm program costs, and reduced medical costs.



But even this does not account for ethanol's 26 additional octane numbers. What's octane worth?

What's an additional octane number worth?



Ethanol's octane is worth between $.59 and $1.68/gal. more than it receives.

Is ethanol economic?

- Ethanol's true production cost is the same or less than either domestic or foreign gasoline.
- Ethanol provides $ .59 - $ 1.68 of additional value to motorists in octane.
- Regulatory Relief Task Force showed ethanol more than offset its $ .60 incentive by reduced farm program expenditures.

ETHANOL

- ☐ ***is economic.***
- ☐ ***is good for clean air.***
- ☐ ***is good for farmers.***
- ☐ ***is good for cars.***
- ☐ ***is good for energy security.***
- ☐ ***and is good public policy.***

But today, ethanol still can't go head-to-head with the largest industry in the world.

What should public policy be when a marketplace is so severely distorted?

☐ Mandate use.

OR

☐ Level the playing field.

Testimony presented in Albuquerque, NM, May 25, 1989, on acid deposition in the West.

My name is John Harte. I am Professor of Energy and Resources at the University of California, Berkeley, and a senior researcher at the Rocky Mountain Biological Laboratory, Gothic, CO.

Beginning in 198[illegible], I have led an intensive research program on acid deposition and its effects in the western United States. Our research site is the Nature Conservancy's Mexican Cut Research Preserve, a watershed in Gunnison County, CO. The fifteen lakes and ponds that we studied are located at 11,000 - 12,000' elevation and span the range of conditions found in thousands of water bodies at high elevation in the western United States. The major results of our research are summarized below.

1. **Acid deposition is occurring.** Average summer rain pH ranges from 4.5 to 4.7 each year and average annual snow pH is about 5.1. The acidity is due in roughly equal measure to sulfuric and nitric acid. Annually averaged acid levels are approximately five times background levels. The higher pH of the winter snow is due to the dilution effect of a greater precipitation volume rather than to a lessening of pollution in wintertime. No distinct trend in annually-averaged precipitation pH has been observed over the period from 1981 to 1988.

2. **Very acid-sensitive lakes and ponds exist within the watershed.** Chemical conditions in fifteen lakes and ponds within the watershed have been closely monitored over the past eight years. We find that six of them are highly sensitive to acidification, using the EPA's classification of lake sensitivity. This sensitivity is the result of the steep mountain slopes, thin soil development, and absence of carbonate-bearing rock in the watershed.

3. **Snowmelt brings a pulse of acidity to the surface waters.** During the period of most intense snowmelt at the site (typically in early June) the acid levels of the surface waters of the more acid-sensitive lakes and ponds increases sharply (their pH's drops to approximately 5.0). Both nitric acid and sulfuric acid contribute to this acid pulse. We call this "episodic acidification". The possibility that this is simply a dilution effect that could result from the melting of pure snow can be ruled out by the fact that a sharp increase in the sulfate ion concentration of the surface waters accompanies the pH reduction. Currently, episodic acidification only lasts for a week or two and only affects the surface waters, but it occurs during the acid-sensitive reproductive stage in the life cycle of many aquatic organisms.

4. **At least one wild population in the Preserve appears threatened by acid precipitation.** A number of biological populations known to be very sensitive to acidity are found within the watershed. These include the the tiger salamander Ambystoma tigrinum, which lays its eggs during the acid pulse at snowmelt. In response to our observation of a significant decline in both the population and the reproductive success of this salamander over the past seven years, we have conducted an extensive series of dose-response experiments to ascertain the cause. Our data (in press, in the journal Conservation Biology) indicate that acid levels occurring during the acid pulse at snowmelt are sufficiently intense to cause major developmental failure in the eggs of this species. Thus, the decline of this salamander population in our watershed may be the first indication of biological damage from acid precipitation in the western United States.

5. **The problem will intensify if emissions are not reduced.** If present levels of pollution emissions continue in the western United continue, then over time the episodic acidification phenomenon observed at snowmelt will last longer and even midsummer acid levels may reach the point where they threaten other forms of life besides the salamanders. Determination of the rate at which this process will occur is one focus of our current research.

Finally, I wish to emphasize that damage from acid precipitation at our research site is only a minor component of the many hazards associated with inadequately controlled emissions of air pollutants in the western United States. There are a multiplicity of benefits associated with an effective cleanup program. These benefits include a reduction of the health hazards in our western cities, a reduction of visibility impairment in our western National Parks, and a reduction of the risk to mountain lakes and possibly even forests throughout the West that are part of the life support system that sustains a significant fraction of the economic vitality of the United States.

Accepted for publication in Conservation Biology

Possible Effects of Acidic Deposition on a Rocky Mountain Population of the Tiger Salamander *Ambystoma, tigrinum*

John Harte
and
Erika Hoffman

Energy and Resources Group
University of California
Berkeley, California, 94720
August, 1988

ABSTRACT

To investigate possible biological effects of acidic deposition in the western United States, we performed population censuses and dose-response experiments at a subalpine watershed in the Rocky Mountains of Colorado. An adult tiger salamander (*Ambystoma tigrinum nebulosum*) population declined by 65% over seven years, while larval recruitment declined over all but the last year of this period. *A. tigrinum* eggs had an LD-50 pH of 5.6, which is within the range encountered by eggs at this site during snow melt. Although the decline of *A. tigrinum* at this watershed could be a natural fluctuation, the available evidence is consistent with the hypothesis that acidic deposition is its cause. Thus, the decline of *Ambystoma tigrinum* at the watershed may be the first indication of biological damage from acidic deposition in the western United States.

INTRODUCTION

Recent studies have demonstrated the susceptibility of some montane lakes in the western United States to anthropogenic acidification and documented the presence of acid precipitation in their vicinity (Lewis and Grant, 1980; McColl, 1980; Liljestrand and Morgan, 1981; Melack et al., 1982; Tonnessen, 1984; Harte et al., 1985). While there has been no documentation of permanent lake acidification in the western U.S., research in the Sierra Nevada of California (Melack et al., 1987) and the Colorado Rockies (Blanchard et al., 1987) has shown that a temporary depression of surface-water pH and alkalinity and a simultaneous increase in sulfate and nitrate levels occurs following spring snow melt. We refer to this transient phenomenon as "episodic acidification". Our focus here is on possible biological damage resulting from episodic acidification of surface waters in the western U.S., where no such damage has yet been reported.

In the eastern United States, where precipitation is more acid than in the West, and where some surface waters are chronically, rather than just episodically acidified, fish populations have been severely depressed or eliminated in acidified lakes (Schofield, 1976). Field and laboratory studies have generally documented that pond acidity also influences amphibian egg mortality and distribution (Gosner and Black, 1957; Cooke and Frazier, 1976; Beebee and Griffin, 1977; Saber and Dunson, 1978; Freda and Dunson, 1985). In particular, Pough (1976) and Pough and Wilson (1977) reported detrimental effects of pH reduction on spotted salamanders (*Ambystoma maculatum*) in New York State. However, Cook (1983), also working with *A. maculatum* in a naturally acidic region in Massachusetts found no correlation between embryonic mortality and pH, and concluded that intraspecific variation exists in acid tolerance.

Here we report census data that indicate a decline in a population of the tiger salamander (*Ambystoma tigrinum nebulosum*) at a subalpine watershed on the western slope of the Colorado Rockies. We then present results of toxicity experiments designed to determine the effects of acidity on the salamander's egg development and on the survival of several zooplankton species that are part of the food chain leading to this salamander population. These studies test whether pH levels encountered during episodic acidification could account for the observed salamander population decline.

SITE DESCRIPTION

The Galena Lake/Mexican Cut Preserve, managed by the Rocky Mountain Biological Laboratory, is located in the Elk Mountains of west-central Colorado (latitude 39°01'30"N, longitude 107°04'00W"). Our specific site within the Preserve is a shelf called the "Lower Cut"; its 0.5 km^2 area varies in elevation from 3400 m to 3450 m. The terrestrial vegetation of the Lower Cut is characterized by open subalpine forest of Engelman spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*).

Annual precipitation averages about 1.5 m, with 80-90% as snow. The precipitation acidity has been monitored on an event basis at the site since 1982; year to year variation in the volume-weighted, mean-annual pH around a value of pH 4.91 is small and no trend in precipitation pH has been observed (Harte et al., 1985).

Within the Lower Cut are 12 permanent and ephemeral ponds seasonally connected by streams. The Lower Cut contains two distinct subdrainages, hydrologically separated by a low quartzite ridge; ponds L-1 to L-5 lie in one and have moderate midsummer alkalinities (150 - 300 ueq/l) and ponds L-6 to L-12 lie in the other and have low midsummer alkalinities (25 - 50 ueq/l) (Harte et al., 1985). While both subdrainages have thin soils, scattered limestone outcroppings are found in the drainage leading to the ponds with moderate alkalinity and not in the other.

All of the permanent ponds (L-1, 5, 8, 9, 10, 11, and 12) are oligotrophic and monomictic, stratifying in the autumn and mixing in late June or early July at the end of snowmelt. Pond areas range from 200 m^2 to 4,980 m^2; mean depths range from 0.5 m to 2.1 m; substrates consist of soft mud sparsely mixed with stone.

As shown in Table 1, the pH's and alkalinities of the ponds in both subdrainages are significantly lower and the nitrate and sulfate concentrations are higher during snowmelt than in midsummer. Table 1 shows that in L-1, the largest of the moderate alkalinity ponds, the midsummer pH is considerably higher than that of L-12, but drops at snowmelt to approximately the same pH as L-12. The episodic pH reduction in pond waters to values in the range of 4.9 - 5.4 occurs in the Lower Cut ponds with moderate midsummer alkalinity (150-300 ueq/l) as well as in those with low (20 - 50 ueq/l) midsummer alkalinity because all the ponds receive a volume of snow melt each year that is comparable to or larger than the ponds' volumes. In all ponds, the pH minimum typically occurs in early or mid June and pH recovery to midsummer levels occurs over a few weeks as a result of alkaline groundwater inflow that is delayed relative to the surface runoff from snow melt. This inflow has an alkalinity which is roughly five times higher in the moderate alkalinity ponds (approximately 300 ueq/l) then in the low alkalinity ones (approximately 60 ueq/l), which is why the midsummer pond alkalinities differ considerably between the drainages.

Figures 1a and 1b show pH measured for L-12 and L-1 during spring and summer, 1984. They illustrate the similar intensity of the pH minimum and shape of the recovery for this pair of low and moderate alkalinity ponds. Blanchard et. al (1987) discusses the details of the spatial dependence of pond chemistry during snow melt. Data from 1984 are shown here because we have the most complete data set for this year. However, they should not be considered representative of other years; there were variations in the timing and intensity of each annual episode from 1984 to 1988, although the rate of recovery from the pH depression was similar in each . Prior to 1984 year, our pond chemistry data cover only the period after the peak of snowmelt so we cannot document episodic acidification then.

Observation of pond organisms is restricted to a brief ice-free season from late June to late October. The predominant aquatic vegetation is quillwort (Isoetes sp.). A. tigrinum is the only vertebrate living in the ponds. Both adults and larvae consume primarily various littoral, benthic, and planktonic arthropods and are only occasionally preyed upon, mostly by dytiscid beetles, Trichoptera larvae (Anderson et al., 1971) and gray jays (Perisoreus canadensis) (R. Willey, pers. comm.). During the period of this study, no collecting or hunting of the salamanders occurred.

METHODS

Chemistry

All pH's referred to in this paper were measured potentiometrically at the time of sample collection; pH accuracies were checked on each occasion by measuring at least two dilute strong acid standards of pH 4.0 and 5.0

(prepared from J.T. Baker "Dilutit" 0.1 M HCl). Measurements were unbiased, with accuracies of individual measurements estimated as $s = 0.05$ pH units. Alkalinities were determined by gran titration (Strumm and Morgan, 1981, p. 226) of samples with 0.01 or 0.05 M HCl; all alkalinities were required to have an r^2 of at least 0.999. Precision was estimated from replicate measurements and accuracies were checked by titrations of standards; both were estimated to be $s = 4$ ueq/l for the low alkalinity ponds. For the analysis of anions, samples were stabilized by filtration (Peden and Skowron, 1978) and transferred to linear polyethylene bottles that had been rinsed with deionized, distilled water, soaked at least 24 hours, and rinsed again. Samples were mailed as rapidly as possible to a laboratory in Berkeley and refrigerated at 4 C prior to analysis. The time from collection to analysis was typically two weeks. Anions were measured on a Dionex 2000i or System 12 ion chromatograph.

Censusing

We counted *A. tigrinum* in all of the Mexican Cut ponds from 1982-1988 at roughly ten day intervals (approx. six counts per year). Counting began in late June, when melt-out first permits observation of *A. tigrinum* at the Mexican Cut, and continued to mid or late August, when most of the salamanders were no longer visible in the ponds. To minimize disruption, counts were made by walking each pond's perimeter and recording each observed salamander. We always made these counts on sunny days between 1100h and 1300h, during which period the salamanders were observed to cluster in the littoral zones of the ponds. In the smaller ponds (L-2,3,6,7,10,11) the entire pond bottom was clearly visible from the shoreline, whereas in the larger ponds (L-1,5,8,9,12) salamanders in deep water could not be counted in the conventional manner. Therefore, to supplement the counting procedure in the larger ponds, we made 2 or 3 visual mid-pond counts from a raft each summer since 1982. These mid-pond counts never revealed more than 10% additions to the shoreline counts.

We conducted two types of validation studies to check the accuracy of our census technique. In 1986, in pond L-3, we compared the result of a census by direct observation from the shoreline to a count obtained one hour later by netting and removing, temporarily, all of the salamanders from the pond. The direct observation method yielded 37 individuals, while the netted count was 44. A second check on our census method compared perimeter counts carried out by different investigators at the same pond within an hour of each other; in 1982, 1985 and 1986, these replicated censuses were conducted at pond L-1, and in 1986 the same was done in L-11 and L-12. The mean, standard deviation and number of observers (n), for each of these replicated censuses were: 169.5, 14.7, (n=4) and 172.0, 7.8 (n=3) and 69.7, 15.1 (n=5) for L-1; 4.7, 1.7 (n=11) for L-11; 9.3, 1.7 (n=3) for L-12. Based on these results and our mid-pond counts we estimate that the counting error in the Mexican Cut total adult population is +20%, -10%.

Approximately half of the present _A. tigrinum_ population at the Mexican Cut has been described as paedogenic, a condition in which sexually mature individuals retain larval characteristics (Levi and Levi, 1955; Sexton and Bizer, 1978). Our census data did not distinguish sexually mature from immature adults nor those which are metamorphosed from those which are not because these distinctions were difficult to make in the field. We distinguish only young-of-the-year (hereafter called hatchlings) from greater-than-one-year-olds (hereafter called adults). All hatchlings were 4-6 cm in length when they were counted.

Dose-Response Experiments

We used microcosms to study the effect of acidity on A. tigrinum egg and zooplankton survivorship. For all of the microcosm dose-response experiments, we used cylindrical, 4-liter, polyethylene containers (16 cm in diameter) filled with 3.6 liters of littoral zone pond water. Removable netting that covered the tops of the containers prevented detritus from entering. We placed the microcosms on a floating raft that allowed pond water to freely circulate around the containers. To discourage predators we tethered the raft in the middle of the pond. We verified that the pond and microcosm water temperatures were nearly identical using max-min thermometers secured to the side of the raft, as well as in an extra microcosm container filled with pond water and in the littoral zone of the test pond. We acidified treatment microcosms with a single dose of concentrated sulfuric acid at the beginning of each experiment and made pH measurements approximately every three days. The average drift in both the control and treatment microcosm pH's for the egg and zooplankton experiments were 0.13 and 0.17 pH units respectively. We made observations of egg and zooplankton mortality every two days on average.

Ambystoma tigrinum eggs from the Mexican Cut were not used in the microcosms because this population is protected by The Nature Conservancy. Instead we collected A. tigrinum eggs (~ 0.8 cm diameter) on 13 June 1987 from an unnamed pond, morphologically similar to L-12 and located 20 km south and 150 m lower in elevation. At the time of collection, the pH and temperature of this pond were 7.00 and 9-11 C respectively and all of the eggs were in either the blastula or early gastrula stages, designated stages 8-12 (Harrison, 1969). Lacking an embryonic development chart for Ambystoma tigrinum, one for Ambystoma maculatum was used as a standard. The eggs were stored in untreated, circumneutral, local spring water for two days prior to experimentation.

We set up five treatments: a control (pH 6.5) and four acidified treatments (pH's 6.1, 5.7, 5.3, and 4.9), using water from L-12. There were three replicates of each treatment. We then randomly apportioned 150 eggs at stages 14-17 into 15 microcosm containers (10 eggs per container), a task made easier because the eggs are laid individually and not in large jelly masses. The raft containing microcosms was floated in L-12 and observations were made for 25 days. In L-12, the temperatures in the microcosms, in the pond littoral zone, and in mid-pond where the raft was tethered were always within 2 C of one another and ranged between 12 C and 21 C over the course of the experiment.

The zooplankton tested for acid tolerance are all abundant and naturally occurring in pond L-11. Two of the species tested (*Diaptomus shoshone* and particularly *Branchinecta coloradensis*) have been identified as components of the larval salamanders' diet (L. McGuire, pers. comm.; Dodson and Dodson, 1971; Dodson, 1970; Sprules, 1972;) The third, *Diaptomus coloradensis* is the most abundant zooplankton species in L-11 and a likely food source for *D. shoshone* (Sprules, 1972). We collected *D. coloradensis*, *D. shoshone*, and *B. coloradensis* using plankton net tows and apportioned twenty *D. shoshone*, four *B. coloradensis* and several hundred *D. coloradensis* into each of 16 containers filled with L-11 pond water. These densities were chosen to resemble those in the more densely populated parts of the pond. We set-up four treatments; a control (pH 6.5) and three acidified treatments (pH's 6.2, 5.8, 5.0). Four replicates of each treatment were observed for 16 days. The raft containing the microcosm containers was floated in the middle of L-11. We counted *D. coloradensis* in multiple withdrawals of a 3.5 cm. i.d. vertical column of water from each container using a polypropylene tube, and counted _B. coloradensis_ and _D. shoshone_ visually in the containers.

RESULTS

Census Data

Figure 2 shows the Mexican Cut total populations (the sum of all ponds) of hatchlings and adult _A. tigrinum_ from 1982 to 1988, the years in which multiple counts were made in all ponds. With the exception of 1982 and 1988, when larval recruitment also occurred in ponds with moderate alkalinity, all recruitment occurred in low alkalinity ponds. The total adult watershed population is plotted because metamorphosed salamanders have been observed to move from pond to pond. Two features stand out: a steady decline, until 1988, in the numbers of hatchlings and a roughly 65% drop in the numbers of adults over the sampling period.

Table 2 shows that both in ponds with low and moderate midsummer alkalinity, the adult population size in the years 1985-88 was less than it was in the years 1982-84 and that the magnitude of the decline is about the same in these two sets of ponds. The table also shows that the particular representation of the census data has little effect on these conclusions.

More limited information on population size is available for years prior to 1982. In 1980 and 1981, we censused only some of the ponds and only once per summer; the results indicate that the populations in those years were larger in both the low and moderate alkalinity ponds than the summer maxima during each of the years from 1985 to 1988. Prior to 1980, we have available only occasional qualitative information. Several observers recall adult populations in the 1960's and 1970's (R. Willey, personal communication; S. Dodson, personal communication) and the hatchling population in 1971 (L. McGuire, personal communication) that greatly exceed those found in the past several summers.

Dose-Response Experiments

Total egg survivorship was inversely related to acidity, showing a sharp and significant decrease between pHs 6.1 and 5.7 (Figure 3). A Pearson Chi-squared test statistic computed for the effects of pH on cumulative final embryonic survivorship was highly significant (X^2=25.98, df=4, p=0.0067). Significance levels for differences in embryonic survivorship between each of the treatments and the control are shown in Table 2. Survivorship in all of the acid treatments except pH=6.1 was significantly different from that in the control systems.

To determine the LD-50 for embryonic response to acidity, we fit survivorship data to a logit dose-response model. This yielded coefficients of determination of r^2=0.58 for day 15 and r^2=0.95 for day 25. By day 15 the LD-50 was pH 5.1 and by day 25, pH 5.6 .

The rate of embryonic development as well as survivorship was also affected by pH. After approximately 16 days of acid exposure, eggs in all but the pH 4.9 container had either hatched or died, whereas in the pH 4.9 containers 37% of the eggs remained alive but had not yet hatched. The straightening of the body and the development of gills and balancers which take place just prior to hatching appeared slowed in these remaining individuals and it took approximately 10 additional days for these eggs to either hatch or die. Our observation that pH affects the rate of amphibian egg development is supported by some previous studies (Gosner and Black, 1957; Nielson et al., 1977; Clark and LaZerte, 1985). However, other studies report opposite results (Pough and Wilson, 1977; Schlichter, 1981).

We observed a variety of developmental abnormalities in the acidified treatments but not in the controls. Eggs in our treatment containers which died during stages 8-28 (Harrison, 1969) were characterized by a perivitelline space which had shrunk and become opaque. None of the control eggs died during these stages. Many of the remaining eggs in the treatment containers showed a noticeable shrinkage in the egg membrane, forcing the developing embryos into a curved position. We observed abnormalities in stages 29 - 38 that included a red discoloration and swelling of the chest in the region of the heart and deformations of the spine and tail. These deformities appeared similar in all acidified treatments but were not observed in the control containers. All embryos which exhibited these deformities died before hatching with the exception of two hatchlings in the pH 5.7 treatment which survived hatching each with a deformed (bilobed) head and curved tail. These two hatchlings rested on their sides, had difficulty swimming, and died within a few days. The abnormalities we observed in the acid treatments are similar to those described for other Ambystoma and other amphibian species in response to acid stress (Pough, 1976; Pough and Wilson, 1977; Gosner and Black, 1957; Pierce et al., 1985; Freda and Dunson, 1985).

The results of the zooplankton dose-response experiment are shown in Figure 4. D. coloradensis experienced 100% mortality after several hours of exposure to pH 5.0, whereas five days elapsed before all B. coloradensis and D. shoshone exposed to this pH were dead. The effects of pH on survivorship of D. coloradensis, D. shoshone, and B. coloradensis were significant (X^2=389, df=3, p<<0.0005; X^2=4990, df=3, p<< 0.0005; X^2=11.33, df=3, p=0.01 respectively). Table 2 shows the statistical significance in survivorship between each of the treatments and the control on the final sampling date. For D. coloradensis, the low p-value for the pH 6.2 treatment is of little practical interest because for most of the experiment survivorship in this treatment tracked that in the control. For D. shoshone, the moderate significance levels for the 5.8 and 6.2 pH treatments are of little practical interest since only 5% of the zooplankton died in these two treatments. We note that for B. coloradensis, although survivorship in the pH 5.8 treatment was greater than that in the control, this difference is not significant.

DISCUSSION: REASONS FOR THE A. TIGRINUM DECLINE

Natural Causes

Climatic fluctuations can have a particularly important influence on high altitude salamander populations. For example, Sexton and Bizer (1978) suggest that the climatic variable most likely to affect the survival of the salamander population at this subalpine site is a short summer season resulting from late snow melt. We compared snow melt and snowfall data gathered at the Rocky Mountain Biological Laboratory (W. Barr, personal communication) during winters 1981-82 and 1987-88 with A. tigrinum census data from summers of 1982 and 1988 (the two summers of highest larval recruitment). In winter of 1981-82 the total snowfall and timing of spring snowmelt were close to average. On the other hand, in the winter of 1987-88, total snowfall was relatively low and snowmelt was unusually early. Moreover, snow melt in the winter of 1984-1985 was unusually late, while that in the winter of 1986-87 was unusually early, and yet larval recruitment was lower in the summer of 1987 than in the summer of 1984. Hence, no consistent pattern is seen linking climatic stress and the salamander decline.

We cannot rule out other natural causes for the decline. Salamander populations are known to fluctuate (Semlitsch, 1983; Shoop, 1974). Although researchers at the Mexican Cut in the 1960-70's did not observe recruitment rates and adult numbers as low as those seen recently, the decline might be a naturally recurring phenomenon, due, for example, to the dominance in the population of a single age class.

Anthropogenic Causes

Possible anthropogenic mechanisms include stresses originating locally from recreational or scientific use of the watershed and acid deposition. During the 1980's, recreational, scientific and other uses of the watershed have been more tightly controlled than at any other time in this century. Moreover, no known local sources of pollution exist. Hence, local anthropogenic stresses are not a likely cause of the salamander population decline.

There are at least five possible mechanisms by which episodic acidification might reduce the salamander population. It might (1) inhibit egg development, (2) exert a direct toxic effect upon the hatchlings, (3) exert a direct toxic effect upon the adult population, (4) inhibit reproductive activity, (5) damage the food chain leading to A. tigrinum.

Our microcosm data indicate that if A. tigrinum eggs are exposed to episodic acidification similar to that occurring at the Mexican Cut, then an increase in embryonic mortality will result. One important question that remains is: are the eggs present at the time of the pulse? There is considerable annual variation in the timing of both the acid pulse and egg laying at the Mexican Cut. In 1988, a year of exceptionally early snow melt, the first eggs were laid at the beginning of the second week of June and a gestation period of 20 ± 3 days was observed. In previous years, we have no direct observations of the timing of egg laying, but assuming the same gestation period, we deduce from observations of hatchlings that eggs were laid during the second week of June in 1982, 1987, and 1988; during the second or third week of June in 1984; and during the fourth week of June in 1986. Only in 1988 did egg-laying occur after pond pH-values had recovered to near their mid-summer levels. The horizontal bar in Figure 1a is an estimate of the period during which salamander eggs were present in L-12 in 1984, based upon the assumptions made above. It suggests that eggs were exposed to pH's in the low 5's for approximately the first week of development.

A second remaining question is: how acidic is the water where the eggs are laid? The pH depression at snow melt is not uniform, with differences of a few tenths of a pH unit observed at different locations in each pond on the same day (Figure 1). However, the episodic pH depression does occur in the shoreline areas where salamander eggs are laid and, in fact, the lowest pH's shown in Figure 1 are from shoreline samples.

Our microcosm results and the discussion above indicate that in the years of declining larval recruitment the developing salamander eggs were subjected to acid levels that could cause significant mortality and sublethal effects. In 1988, the early melt and a spring snow pack that was less acidic than average resulted in pond-pH values of 6 or above during egg development. This could explain the resurgence of larval recruitment that year.

Because the eggs in the microcosms were subject to an acid environment throughout their development, we cannot deduce from our experiment whether there is a critical acid-vulnerable stage for embryos. Thus we do not know if the full 25 days of exposure, determined from the logit model, is required to achieve 50% mortality (LD-50) at pH = 5.6 or whether a shorter exposure during a critical life stage would suffice. Some information is available, however, from another experiment we conducted in 1988. Microcosms containing *A. tigrinum* eggs were acidified to a pH of approximately 5.75 for different 5 day intervals throughout gestation. Following those intervals, the eggs were returned to control pH's of 6.4 . Although these experiments should be viewed as a preliminary study only, the results suggest that the period of greatest sensitivity to acidity occurs between the 5th and 10th days of egg development (neurulation) and that only a brief exposure to acid is needed to induce mortality.

The decline in the salamander population in the individual ponds is not correlated to midsummer pond alkalinity. This might appear to rule out acidity as a cause of the decline. However, if episodic acidification is responsible, then the absence of such correlation is expected because at snowmelt a roughly similar pH depression occurs in all ponds for reasons discussed earlier (Figure 1). For alpine and subalpine ponds and small lakes surrounded by steep slopes and thin soils, midsummer alkalinity is a poor indicator of susceptibility to damage from episodic acidification.

It is unlikely that the observed decline in numbers of salamander hatchlings resulted from acid-induced larval mortality; the earliest in the season that the hatchlings emerge is late June, a time when all ponds have nearly recovered from the acid pulse. Moreover, studies indicate that amphibian hatchlings are less sensitive to acidity than embryos (Gosner and

Black, 1957; Clark and Hall, 1983; Freda and Dunson, 1984, 1985; Pierce et al., 1984).

We did not test the hypotheses that adult salamanders or fertilization activity are impaired by episodic acidification. Evidence that the first of these hypothesis is unlikely to be correct comes from Pierce et al. (1984), who report that acid tolerance in Connecticut wood frogs increases with age However, with respect to the second hypothesis, amphibians have been reported (Beebee and Griffin, 1977) to avoid breeding in low pH ponds; thus the episodic acidification at the Mexican Cut could have caused metamorphosed adults to leave the ponds prior to egg deposition.

Although the zooplankton data suggest that the three test species are susceptible to acid stress, we cannot conclude that acid-induced mortality is actually taking place because we have no observations documenting the abundance of these species at the time of episodic acidification. For all of the zooplankton species tested, our data indicate that the LD-50's occur somewhere between pH 5.0 and 5.8. A value falling near pH 5.8 would be particularly important since several of the ponds presently have mid-summer pHs around 6.0 and over time these mid-summer pH's could decline slightly if acidic deposition continues.

A number of issues pertinent to the question of whether episodic acidification is adversely affecting the salamander population have not been addressed by this study. We have not attempted to determine the effect on the salamander population of a given reduction in egg survivorship or in zooplankton populations. We have also not investigated whether salamander mating and fertilization activity overlaps in space and time the episodic increase in pond water acidity. We did not examine the dose-response function of the zooplankton populations present at the time of the episode. With the exception of 1988, our estimate of the degree of overlap between salamander eggs and the acid pulse is based on back calculations derived from observations of hatchlings rather than from direct observation of egg-laying. And, finally , available information on the long-term (prior to the 1980's) time dependence of precipitation and pondwater chemistry and salamander populations in the ponds is sketchy or absent. Because of these gaps, we can conclude only that the available evidence is consistent with the hypothesis that episodic acidification has affected the salamander population by impairing embryonic development.

We are unable to explain why the decline is so dramatic in the 1980's. Precipitation at the Mexican Cut was probably more acidic in the 1970's then the 1980's because sulfur dioxide emissions declined during that period in the southwestern and mountain states and an increase in NOx emissions probably did not compensate (Knudson, 1986).

CONCLUSION

Population censuses reveal a decline in the adult population of the tiger salamander, Ambystoma tigrinum, at an acid sensitive watershed in the Colorado Rockies. Hatchling numbers declined steadily until 1988. Dose-response data show a higher incipient lethal pH for an amphibian species than has been reported before and suggest that episodic acidification could account for the observed salamander population decline. At this time, however, other causes cannot be ruled out. A resurgence of larval recruitment in 1988 could be viewed either as support for the acidification hypothesis, because the pulse was unusually weak that year, or as evidence that the salamander population is undergoing a natural fluctuation.

If the resurgence in A. tigrinum recruitment at the Mexican Cut in 1988 is short-lived, the population may be rapidly heading towards extinction. As was the case in other locations in the U.S. and Europe, where acid deposition is more intense, the localized decline of an acid sensitive species in the western U.S. may be the harbinger of more widespread damage.

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	pH	alk (ueq/l)	SO4 (ueq/l)	NO3 (ueq/l)	mean depth (m)	area (m^2)
L-12						
midsummer	6.4-6.8	25-35	10	<3	1.4	1700
peak snowmelt	5.0	0	30	20		
L-1						
midsummer	7.5-7.9	200-300	20-40	<3	2.1	4980
peak snowmelt	5.2	0-10	40-60	10		

Table 1. Chemical and morphological data for a low alkalinity (L-12) and a moderate alkalinity (L-1) pond. Chemical values refer to concentrations in the top meter of pond water; "peak snowmelt" refers to the typical pH minimum.

	1982-1984	1985-1988
Moderate Alkalinity Ponds		
Summer Average	278	133
Summer Maximum	342	175
Sum of Pond Maxima	391	191
Low Alkalinity Ponds		
Summer Average	56	28
Summer Maximum	61	40
Sum of Pond Maxima	82	54

Table 2. Adult salamander census results averaged over the years 1982-1984 or 1985-1988 and summed over the ponds with low or moderate midsummer alkalinity. The Summer Average is the average of all censuses carried out over a two month interval centered around the population maximum. The Summer Maximum is the sum over all the ponds on the day in which the total Mexican Cut salamander population was at its summer maximum. The Sum of Pond Maxima is the sum of the individual pond maxima, whenever they occurred during the summer.

A. tigrinum eggs

pH	4.9	5.3	5.7	6.1
p	<0.0005*	0.0008*	0.0074*	0.41

D. coloradensis

pH	5.0	5.8	6.2
p	<0.0005*	<0.0005*	<0.0005*

D. shoshone

pH	5.0	5.8	6.2
p	<0.0005*	0.021	0.023

B. coloradensis

pH	5.0	5.8	6.2
p	0.0084*	0.22	0.86

Table 3. Significance levels for differences in survivorship between acidified treatments and controls in the egg and zooplankton experiments using a normal approximation to the binomial distribution. Asterisks mark the subset of treatments for each species that are significantly different from the control at the 0.05 confidence level using a Bonferroni multiple pairwise comparison test (Miller, 1981).

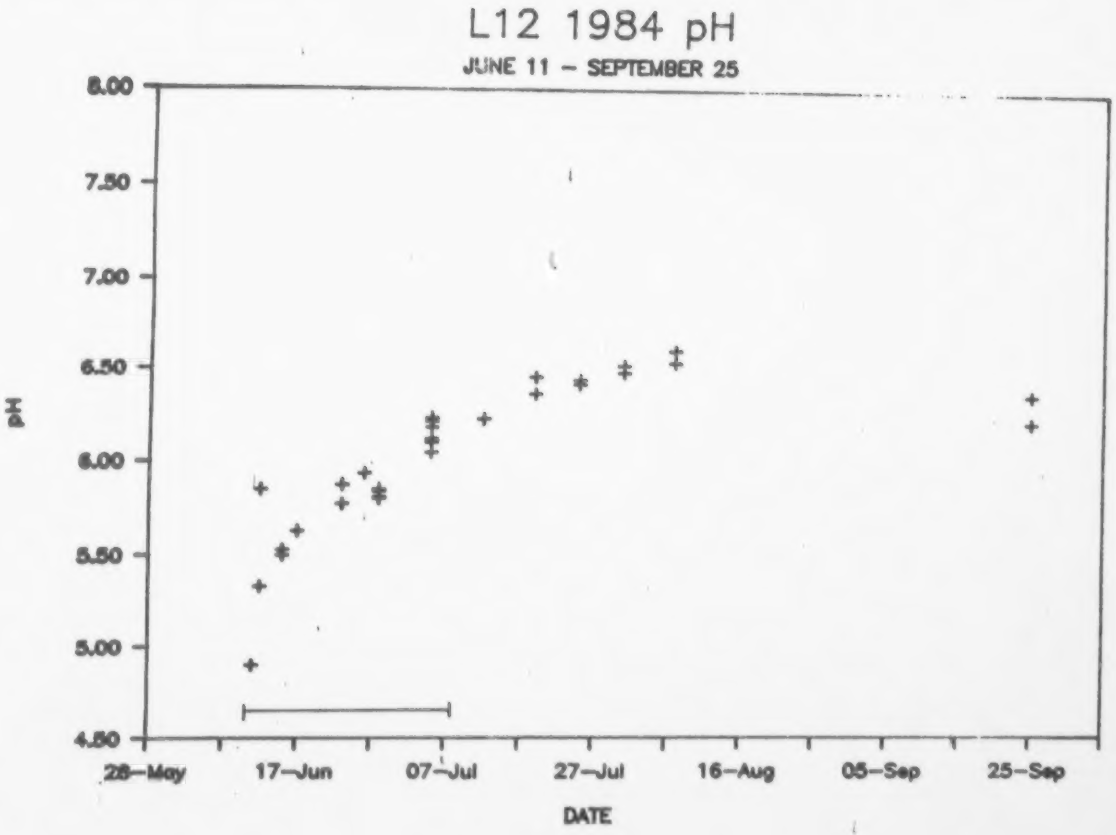
Figure Captions

Figure 1. Measured pH values in 1984 for a) a low alkalinity pond, L-12 and b) a moderate alkalinity pond, L-1. The measurements were made at a variety of surface locations and depths. The horizontal bar in 1a denotes an estimate of the gestation period of *A. tigrinum* eggs in 1984 (see text).

Figure 2. Numbers of *A. tigrinum* hatchlings and adults at the Mexican Cut. No hatchling counts were made in 1983. For each year, the adult census figure represents the total Mexican Cut population on the census day for which the maximum population was observed. In 1986, two hatchlings and, in 1987, one hatchling were observed. In the years 1982 and 1988, large numbers of hatchlings made accurate counts impossible but numbers were estimated to be in the range of 500-1500.

Figure 3. Survivorship of *A. tigrinum* eggs as a function of pH. The means of the standard deviations determined from the replicate counts of the control and pH = 6.1, 5.7, 5.3, and 4.9 treatments are 2.0, 0.97, 0.50, 1.3 and 1.1 respectively.

Figure 4. Effect of acidity on zooplankton a) *D. coloradensis*, b) *D. shoshone*, and c) *B. coloradensis*. The means of the standard deviations determined from the replicate counts of the control and pH = 6.2, 5.8, and 5.0 treatments are, for *D. coloradensis*: 19, 32, 13, and 0 respectively; for *D. shoshone*: 0.70, 1.0, 1.2, and 0.34 respectively; for *B. coloradensis*: 0.57, 0.87, 0.47, and 0.11 respectively.


L12 1984 pH
JUNE 11 - SEPTEMBER 25
pH
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
28-May
17-Jun
07-Jul
27-Jul
16-Aug
05-Sep
25-Sep
DATE

Figufe 1a

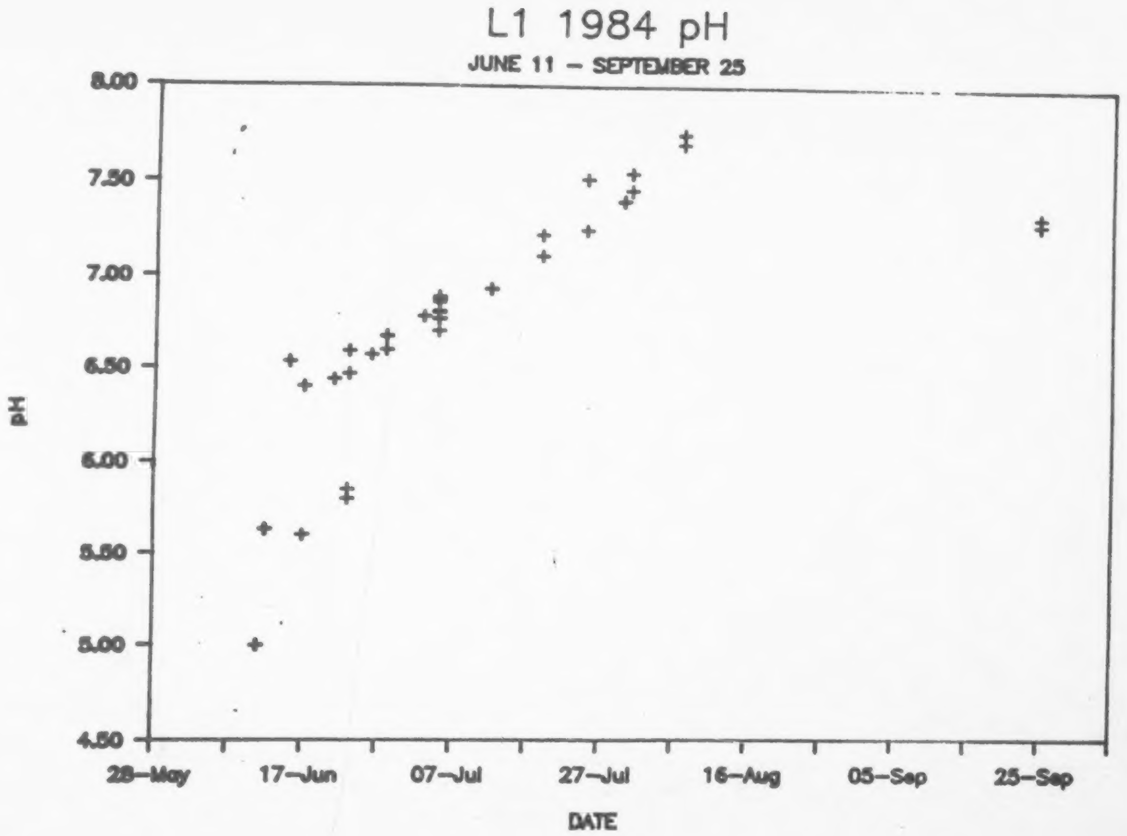
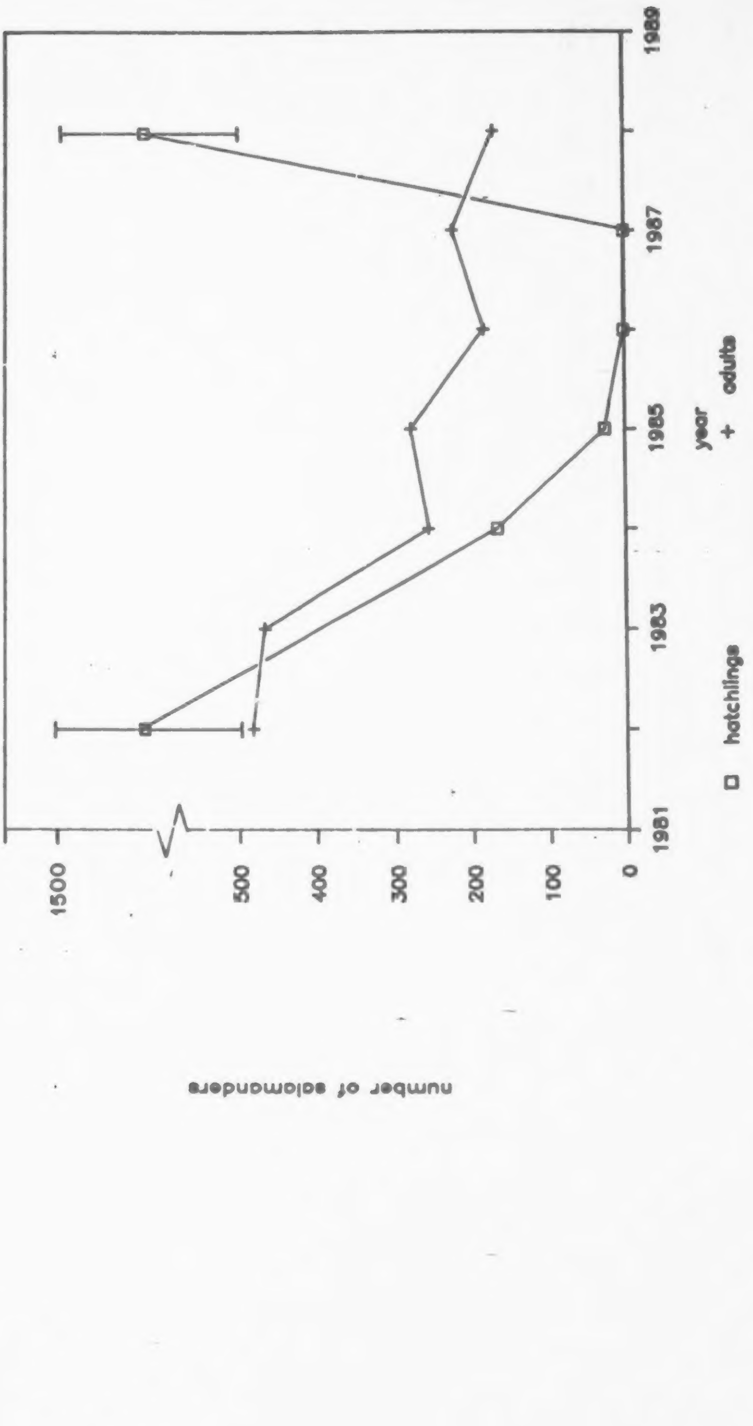
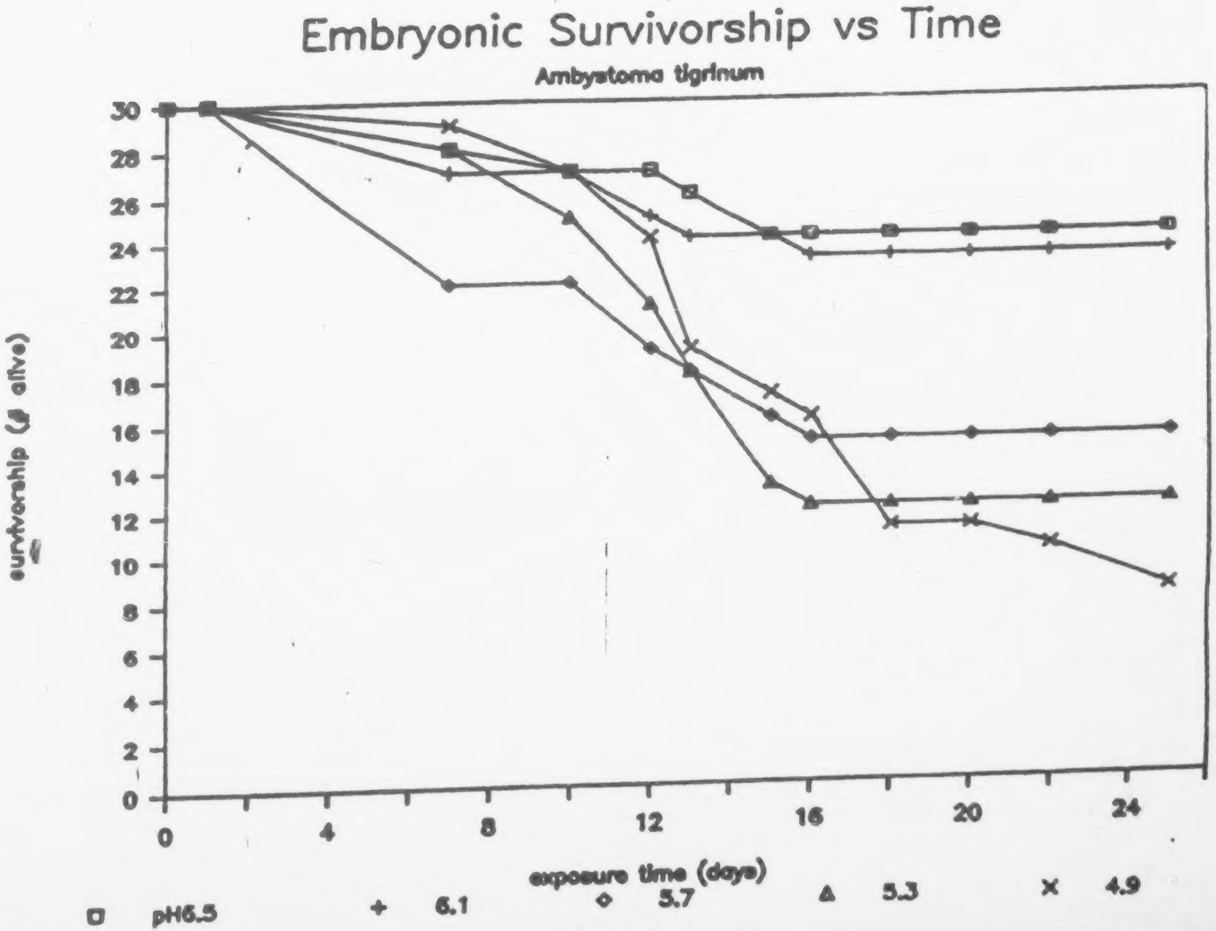

L1 1984 pH
JUNE 11 – SEPTEMBER 25
pH
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
28–May
17–Jun
07–Jul
27–Jul
16–Aug
05–Sep
25–Sep
DATE

Figure 1b



number of salamanders
1500
500
400
300
200
100
0
1981
1983
1985
1987
1989
year
□ hatchlings
+ adults

Figure 2


Embryonic Survivorship vs Time
Ambystoma tigrinum
survivorship (# alive)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
4
8
12
16
20
24
exposure time (days)
□ pH6.5
+ 6.1
◇ 5.7
△ 5.3
× 4.9

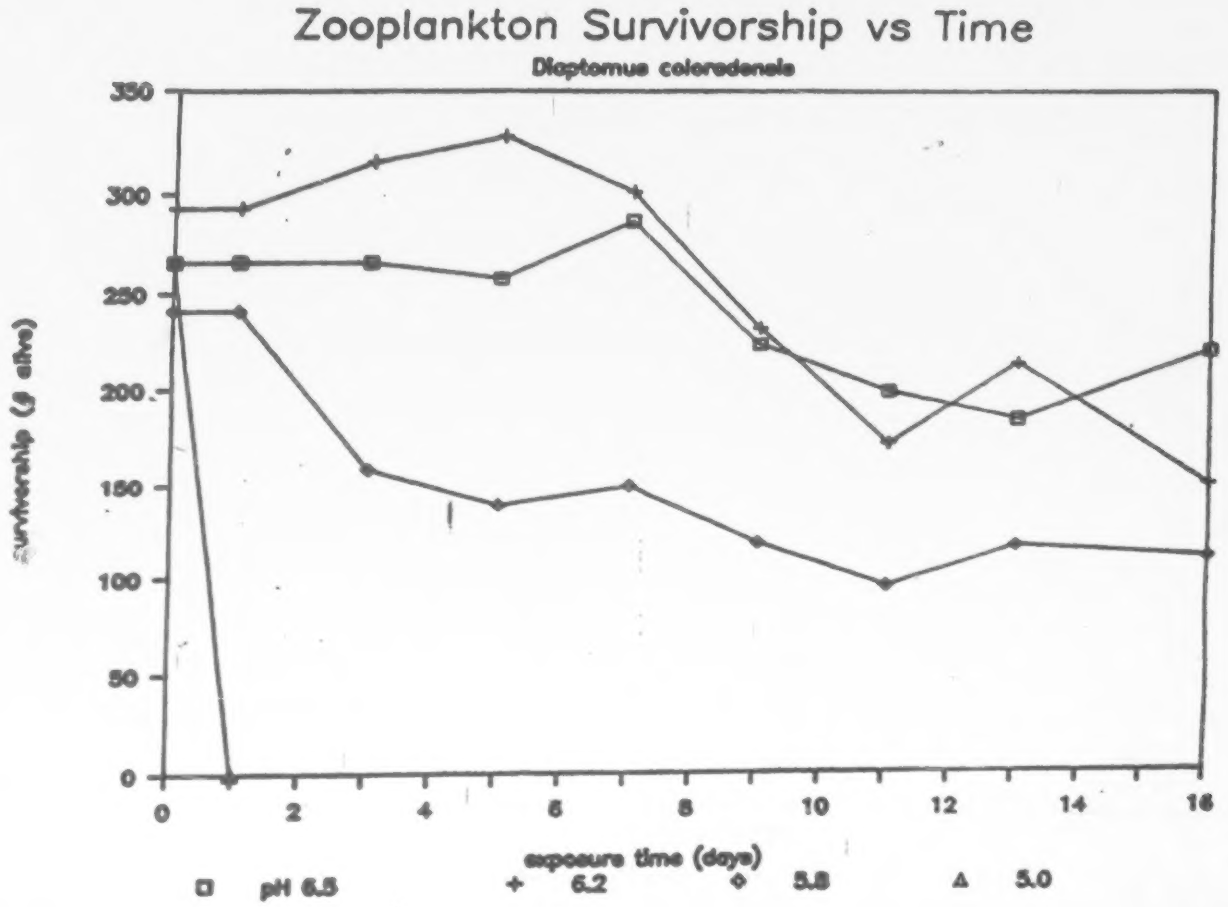

Zooplankton Survivorship vs Time
Diaptomus coloradensis
survivorship (# alive)
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
exposure time (days)
□ pH 6.5
+ 6.2
◇ 5.8
Δ 5.0

Figure 4a

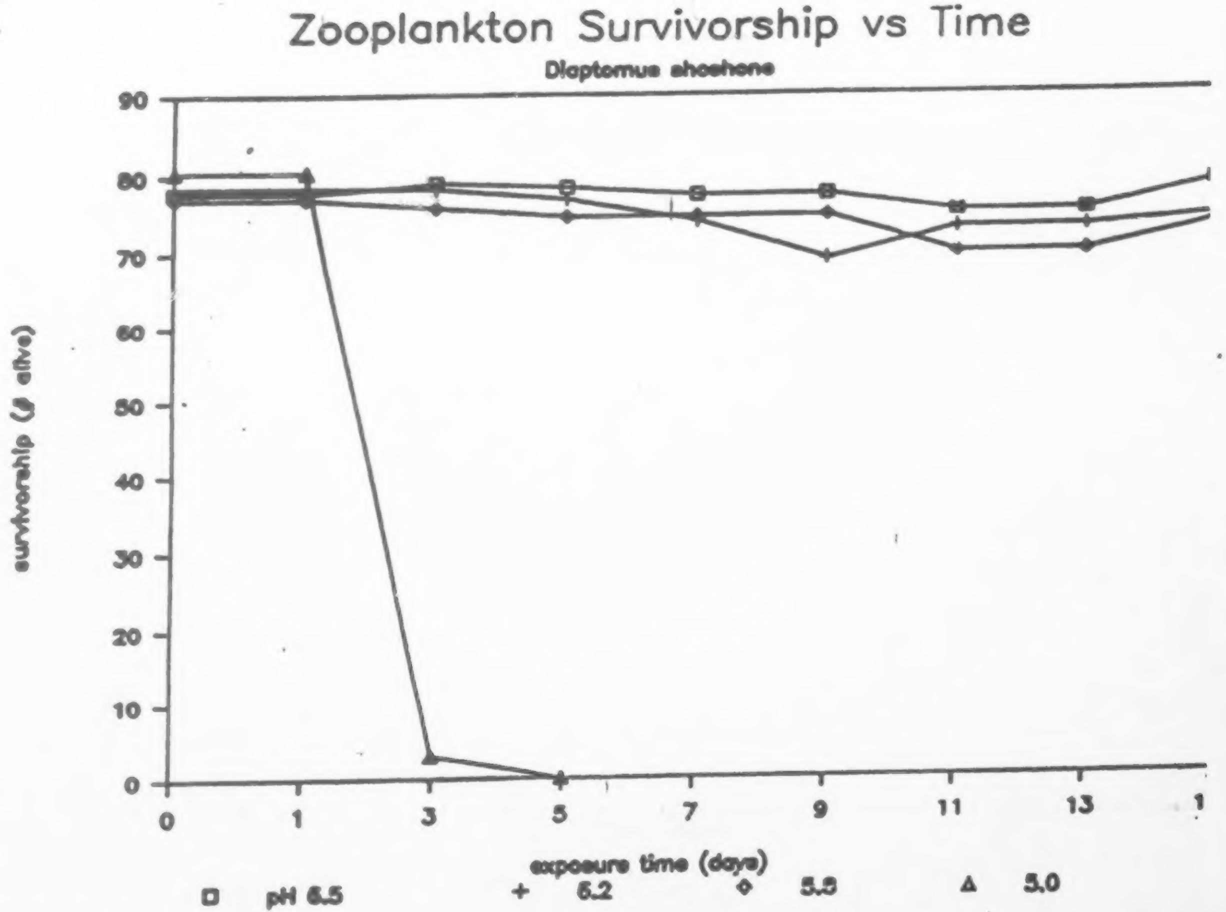

Zooplankton Survivorship vs Time
Diaptomus shoshone
survivorship (# alive)
90
80
70
60
50
40
30
20
10
0
0
1
3
5
7
9
11
13
1
exposure time (days)
□ pH 6.5
+ 6.2
◇ 5.8
△ 5.0

Figure 4b

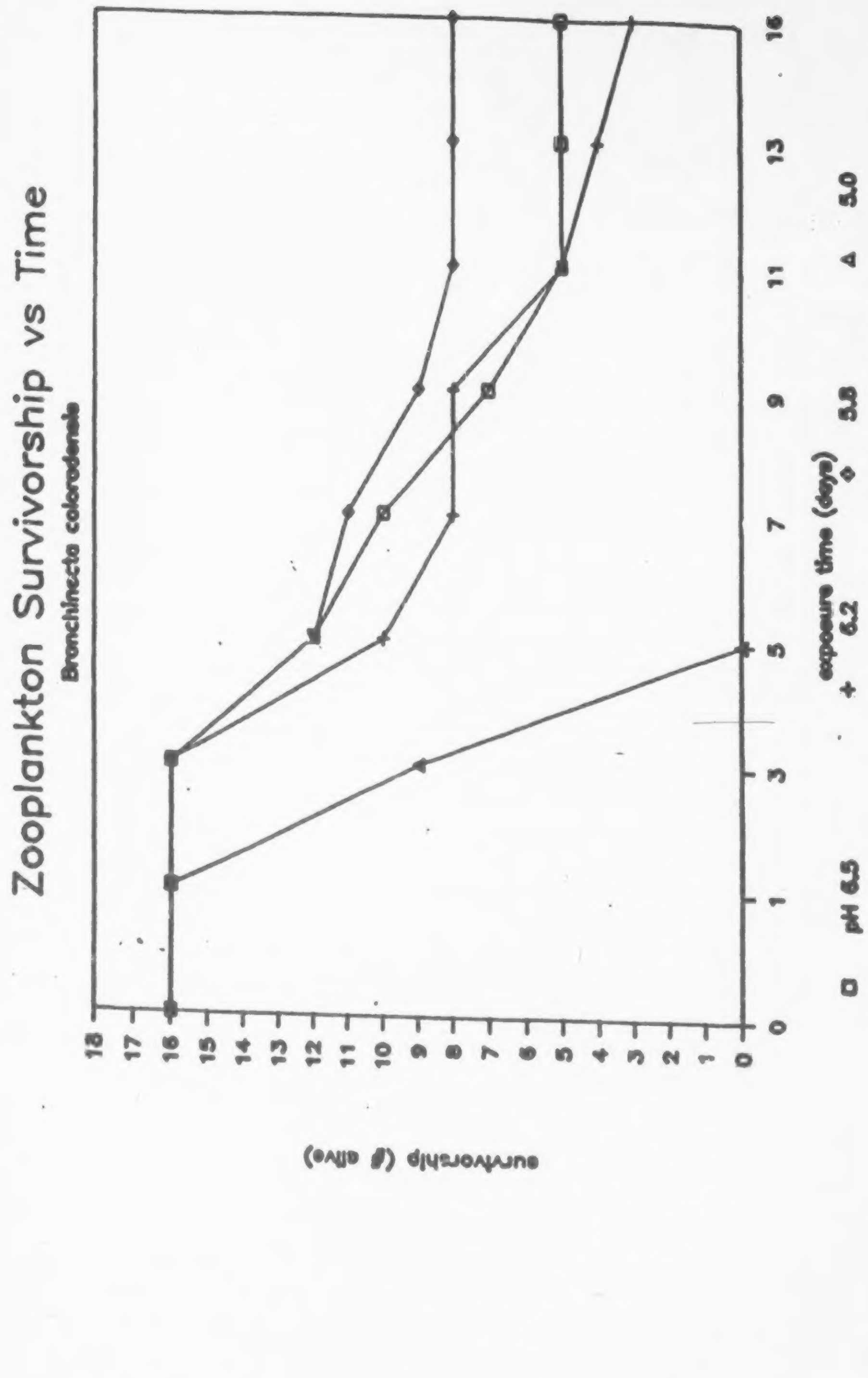

Zooplankton Survivorship vs Time
Branchinecta coloradensis
survivorship (# alive)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
exposure time (days)
0
1
3
5
7
9
11
13
16
□ pH 6.5
+ 6.2
◇ 5.8
Δ 5.0

Figure 4c

ACID PRECIPITATION AND SURFACE-WATER VULNERABILITY ON THE WESTERN SLOPE OF THE HIGH COLORADO ROCKIES

JOHN HARTE, GREG P. LOCKETT, RICHARD A. SCHNEIDER, HARVEY MICHAELS, and CHARLES BLANCHARD

Energy and Resources Group, Bldg. T4, Room 100, University of California, Berkeley, CA 94720, U.S.A.

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Abstract. Precipitation and surface waters in a high-elevation watershed on the western slope of the Colorado Rockies were studied over a three-year period. The volume-weighted average pH for summer events was 4.61, for winter events was 5.11 and for the entire period was 4.91. Within the watershed, both low- and medium-alkalinity surface waters exist. Weekly alkalinity measurements ranged from 10 to 70 μeq L^{-1} in the former and 100 to 900 μeq L^{-1} in the latter.

1. Introduction

Subsequent to its discovery and documentation in Scandinavia and in northeastern North America, acid precipitation has been reported in several locations in the western U.S., notably southern and central California (Liljestrand and Morgan, 1978; McColl, 1980) and the eastern slope of the Colorado Rockies (Lewis and Grant, 1979a, 1980; Grant and Lewis, 1982). The study reported here extends our knowledge of the incidence and potential effects of acid precipitation to the western slope of the Colorado Rockies, where, to date, no event-based sampling has been reported for high-elevation sites. Our site is one of very few western sites that is distant from highways, point sources, and major urban areas, and that receives consistently acidic precipitation. The closest sources of acid precursors are smelting and energy-related activities in Arizona, New Mexico, Utah, and Wyoming. More distant sources may also contribute acidity to western slope precipitation.

Increased fossil fuel consumption in California, the Great Basin, or the upper or lower Colorado River drainage regions could lead to increased acidity of precipitation in the Rockies. The occurrence of acid precipitation at such a remote and sensitive location led us to begin a long-term investigation of the precipitation and surface waters of the western slope. The resulting data provide a means of assessing the present sensitivity of watersheds in the region to acidification and ultimately will allow determination of trends. We report here our first results, which demonstrate the occurrence of acid precipitation and the susceptibility to acidification of alpine lakes in this area.

2. Site Description

Our study site is a remote and relatively pristine high-elevation watershed located in the Elk Mountains of west-central Colorado. The specific site is the Galena Mountain/

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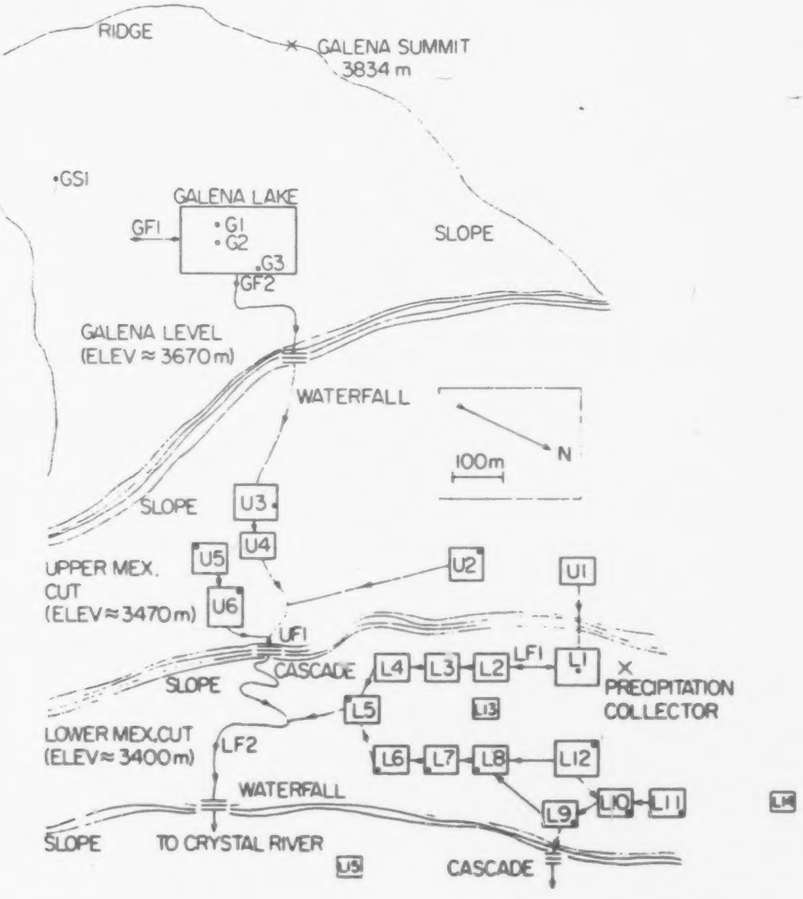
Mexican Cut Preserve (latitude 39°01′30″ N, longitude 107°04′00″ W), in Gunnison County, Colorado, on land largely owned by the Nature Conservancy. The preserve is a hydrologically self-contained watershed on the eastern side of Galena Mountain. It has never been logged and earlier mining operations have been inactive for several decades. Galena Mountain is composed of the Morrison and Maroon formations, which include metamorphosed quartzite, siltstone, sandstone, and shale. Near the peak of Galena Mountain and surrounded by it on three sides is Galena Lake, a tarn of approximate area 30 000 m^2, maximum depth 12 m, and elevation 3670 m. The terrain surrounding Galena Lake is alpine tundra. The topography below Galena Lake consists of two shelves (the Mexican Cut). The Lower Cut is open subalpine forest of englemann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) (Weber, 1956). The Upper


RIDGE
GALENA SUMMIT
3834 m
•GSI
GALENA LAKE
GFI
•GI
•G2
•G3
GF2
SLOPE
GALENA LEVEL
(ELEV ≈ 3670 m)
WATERFALL
100m
N
SLOPE
U3
U4
U5
U2
UI
UPPER MEX.
CUT
(ELEV≈3470 m)
U6
UFI
CASCADE
L4
L3
L2
LFI
LI
SLOPE
X
PRECIPITATION
COLLECTOR
L5
L13
LOWER MEX.CUT
(ELEV≈ 3400 m)
LF2
L6
L7
L8
L12
WATERFALL
L9
L10
L11
L14
SLOPE
TO CRYSTAL RIVER
U5
CASCADE

XBL 825-674

Fig. 1. A schematic map of the Galena Mountain/Mexican Cut Watershed.

Cut is characterized by sparse, dwarfed spruce and fir, or 'krummholz'. Some outcroppings of limestone occur in the Upper Cut. Ponds are situated in both the Upper and Lower Cuts, which from the time of snow melt until mid-summer are connected by small streams as shown in Figure 1. As summer progresses, these surface flows dry up.

The Lower Cut contains two parallel drainages separated by a low quartzite ridge. The separation is nearly complete hydrologically, since concentrations of some chemical species vary greatly from one drainage to the other. In particular, alkalinity ranges from 200 to 350 μeq L^{-1} in the drainage that is situated closest to the Upper Cut and from 20 to 70 μeq L^{-1} in the other drainage. Earlier investigation by Dodson (1982) showed a wide spectrum of biological and chemical conditions among six of the ponds in the Lower Cut. Four of Dodson's ponds are in the low-alkalinity drainage; the other two are in the high-alkalinity drainage. For the surface water measurements of this study, we sampled at Dodson's sites plus 23 others, including additional ones in the Lower Cut, several in the Upper Cut, and several in Galena Lake and its inflow streams.

3. Methods

Surface water was collected in 1 L, linear-polyethylene bottles. Rain was collected in plastic buckets (Aerochem Metrics) mounted to avoid the collection of rain splash and located in a meadow 20 m from the nearest trees. The collectors were uncovered manually at the onset of precipitation and covered after rainfall ceased. Snow was collected on a snow board in a meadow near the Rocky Mountain Biological Laboratory, about 10 km southeast of the study site at an elevation of 2900 m. Rain and snow were collected on an event basis. Events ending during the night were collected early the next morning; those ending during the day were collected within minutes after the end of each event. (An event is a discrete, more or less continuous precipitation period, such as a storm.) Some events were sampled at subintervals during the event.

The pH of precipitation and surface waters was determined potentiometrically. For the period 7/80–5/81, pH's were read while stirring. Subsequently, they were read unstirred. Tests conducted on the type of electrode used from 7/80–5/81 demonstrate that stirred measurements are 0 to 0.1 pH units lower than quiescent readings. While the earlier measurements are thus not strictly comparable to the later, the bias is small. The alkalinity of surface-water samples was measured by titrating with strong acid; endpoints were determined using the Gran method (Galloway *et al.*, 1979; Gran, 1950). Precipitation pH measurements were usually made within 6 hr after collection and always within 24 hr. Alkalinity and pH of surface waters were generally measured within 6 hr of collection. Precision of pH measurements was $s = 0.06$ pH units. The precision of alkalinity measurements varied with alkalinity, $s = 4.09 + 0.023(\text{alk})$ μeq L^{-1}. Commencing 8/82, the accuracies of pH and alkalinity measurements were checked through use of dilute strong acid and Na_2CO_3 standards. From 7/81 to 7/82, pH measurements were verified by determining strong acidity (using the Gran method), using multiple electrodes, or extensively repeating measurements.

TABLE I

Precipitation [H⁺] averages as pH.

Time period	Dates	Number of events	Event average (pH units)[a]	Precipitation amount (cm)[b]	Precipitation weighted average (pH units)[c]
Summer I[d,e]	7/80	4	4.4		
Winter I[e]	12/80–5/81	35	4.2	28.7	4.3
Summer II	7/81	14	4.64	7.3	4.68
Winter II	11/81–4/82	40	5.11	54.0	5.17
Summer III	6/82–9/82	59	4.50	13.3	4.48
Winter III	11/82–5/83	43	5.10	50.4	5.16
Summer IV	6/83–9/83	32	4.62	20.2	4.69
Winter IV	11/83–5/84	40	4.97	64.1	5.03
Summer V	6/84–8/84	31	4.56	22.9	4.62
All summers[e]		136	4.54	63.7	4.61
All winters[e]		123	5.07	168.5	5.11
Entire period[e]	7/81–8/84	259	4.72	232.2	4.91

[a] Event average $= -\log \Sigma_{i=1}^{N} [H_i^+]/N$, where N = number of events for the time period.

[b] Precipitation amount is the liquid depth of the precipitation contributing to the sample (water equivalent for snowfall).

[c] Precipitation-weighted average =

$$= -\log \left\{ \frac{\sum_{i=1}^{N} [\mathrm{H}^+]_i \,(\text{precipitation amount})_i}{\sum_{i=1}^{N} (\text{precipitation amount})_i} \right\}$$

whree N = number of events.

[d] Precipitation amounts not measured. Not all events were sampled.

[e] Summer I and Winter I not included in averages.

4. Results and Discussion

Table I shows averages of the H⁺ concentrations over each of the summer and winter precipitation seasons. Precipitation occurs as snowfall from about November to May; most of the remainder of the year's precipitation is due to thunderstorms in July and August. Data are presented separately for summer and winter because the chemical composition of snowfall may be quite different from that of rain. The difference in location of the summer and winter sampling sites appears unimportant, as judged by some summer measurements made simultaneously at the two sites. All 15 of the precipitation samples with pH ≤ 4.1 occurred the first winter (1980–81). In the subsequent three winters, there occurred only five events with pH ≤ 4.5. The data from the first winter are clearly unusual. Since pH accuracy was not routinely checked until 7/81, we exclude the first summer and first winter from the computations of averages. Data from the excluded periods are included in Table I for completeness, however. It is possible that the atypical results for winter I are related to the unusually dry weather that winter (snowfall was about half that occurring the following three winters). Precipitation pH's were high (5.6 to 6.8) during April or May of each of the four years. Mean pH was similar for each of the summers, with little variation about the mean in each case. All summer average pH's were lower than the winter averages. These data contrast with observations reported elsewhere that the widest range of pH's occur in summer (Johannes *et al.*, 1981).

The seasonal variation described above and further analysis of the precipitation data indicate that the underlying mechanisms controlling precipitation chemistry at this site are complex. Individual event H^+ concentrations correlate negatively with event water volume ($r^2 = 0.23$, $n = 259$) but only weakly with the time interval since the last event ($r^2 = 0.02$, $n = 255$). The data thus show some dilution of acidic materials with increasing storm volume, although the effect is insufficient to account for the major portion of the variation in H^+ concentration. The data do not demonstrate a simple washout effect that might be attributable to frequency of precipitation. These results do not change appreciably if the data of each season are analyzed separately. A plausible contributing factor is airborne dust from the alkaline soils of the Great Basin (Winkler, 1976). Long intervals between storms may allow acidic materials to build up in the atmosphere under some circumstances, and, under other circumstances, allow alkaline agents to build up.

Table II shows results of measurements of pH and alkalinity at representative surface-water sites in the watershed. At about half the lentic sites, the alkalinity averaged approximately 40 μeq L^{-1} throughout the ice-free periods of 1981, 1982 and 1983. This low alkalinity indicates vulnerability to acidification. The highest weekly alkalinities (400

TABLE II

Surface water pH and alkalinity

Site	Average pH			Average alkalinity (μeq L^{-1})		
	1981	1982	1983	1981	1982	1983
L1	7.49	7.20	7.30	222	226	235
L5	7.22	6.84	7.22	205	220	248
L8	6.43	6.18	6.43	39	31	45
L9	6.24	6.24	6.23	25	25	41
L10	6.06	6.15	6.22	59	40	56
L12	6.69	5.34	6.32	28	19	34
LF2	7.43	7.23	7.38	207	199	232
U3	7.53	7.22	7.11	175	118	131
U4		7.22	7.15		132	157
U5	7.72	7.44	7.42	462	445	459
U6	8.10	7.24	7.71		445	691
UF1	7.54	7.22	7.23	332	161	221
G	6.66	6.29	6.51	30	18	31
GF1	6.33	6.12	6.24	15	13	20
GF2	6.46	6.28	6.46	23	18	26

to 900 μeq L^{-1}) in the watershed were found in ponds U5 and U6. These ponds are situated near the limestone outcroppings of the Upper Cut, and geological maps indicate the presence of subsurface limestone in the drainage above these ponds, suggesting that inflowing ground water in contact with limestone is the source of the alkalinity.

Of particular interest in studying watershed acidification are long-term trends in alkalinity. Dodson measured alkalinities during summer, 1972, for six ponds in the Lower Cut (Dodson, 1982, 1983). Alkalinity measurements for these six ponds for 1972, 1982, and 1983 (and 1981 measurements for two of these ponds) are plotted in Figure 2. An endpoint correction was applied to Dodson's 1972 data (Stumm and Morgan, 1981) to account for the difference in methods of computing alkalinity. We determined alkalinities using Gran functions; Dodson titrated to a fixed pH (5.20). Our alkalinities are generally at or below the levels reported for 1972. Unfortunately, we cannot rule out

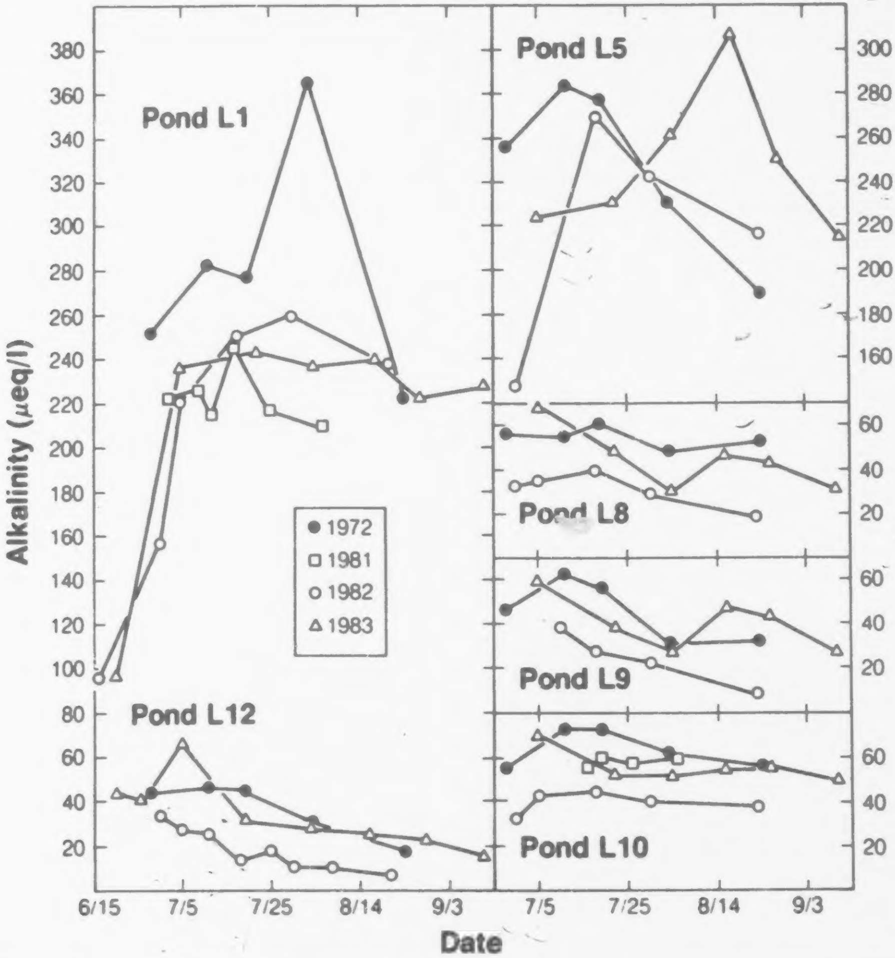


Fig. 2. Summer alkalinity data for ponds L1, L5, L8, L9, L10 and L12 for 1972, 1981, 1982, and 1983.

differences in measurement technique as the source of the difference between our measurements and the earlier data. Furthermore, the annual variations displayed in the more recent years are large. We find the differences between ours and the earlier data suggestive, but cannot conclude that a trend exists in surface-water alkalinity over the 10 yr period.

The annual and weekly variations, however, are larger than can be explained by analytical and sampling error. These variations, as well as differences between 1972 and the present, cannot be accounted for by processes such as plant succession or soil formation because the time-scale of the variations is too short. Nor can the effects of human land use play a role, since the watershed was never logged and is now utilized only for research. It is more likely that short-term variability is caused by hydrological factors. The volume of precipitation can cause seasonal changes in alkalinity by varying the hydrologic flushing rate in a watershed (Lewis and Grant, 1979b). An unusually late snow melt in 1983 and the occurrence of very heavy storms that summer may account for the differences between 1982 and 1983. Biological factors, such as productivity, may explain a portion of the weekly variability in all years. In order to separate long-term trends from short-term fluctuations, both a better understanding of the site-specific factors affecting surface-water alkalinity and data covering a longer time span are needed. If weekly and annual alkalinity variation as large as those reported here are common in other surface water of the Rockies, any assessment of long-term alkalinity trends will clearly require measurements made throughout the late spring and summer over a period of many years.

The work reported here is part of a long-term research project to assess the chronology of acidification and to identify ecological changes attributable to acid precipitation. The close proximity of two drainages in the Lower Cut, one more vulnerable to acid precipitation than the other, affords an unusual opportunity to study the effects of acid precipitation over an extended period. Alkalinity, pH, anion, and cation measurements for surface-water samples are being made on a regular basis. *Ambystoma tigrinum*, a species of salamander inhabiting many of the ponds in the Mexican Cut, is being censused regularly. Since this species belongs to the same genus as the acid-sensitive spotted salamander (*Ambystoma maculatum*) of the Adirondacks (Pough, 1974), it may serve as a valuable biological indicator of decreasing trends in surface-water pH. Other populations that may serve as useful indicators are cutthroat trout (*Salmo clarki*), lichens living above timberline, and several species of *Daphnia*, including the acid-sensitive *D. pulex* (Davis and Ozborn, 1969). A discussion of the associations between the *Daphnia* populations and the specific physico-chemical conditions in the individual ponds is given by Dodson (1982).

5. Conclusion

The results reported here establish the occurrence of acid precipitation at the study site. Most surface waters are poorly buffered, and biological species sensitive to acidification are present. This combination of factors indicates that the Galena/Mexican Cut watershed could undergo adverse ecological changes from acid precipitation.

Acknowledgments

We are grateful to the Rocky Mountain Biological Laboratory for the use of facilities and to its staff and members for helpful discussions. We are particularly indebted to B. Barr for snow collection and pH measurements. The cooperation of the Nature Conservancy in permitting this research on its land has been vital.

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Air Quality

June 5, 1989
Star Rt. Box 150
[illegible]llo, N.M. 87004

SENATOR BINGAMAN
ALBUQUERQUE, N.M.
JUN -7 AM 9 35

Sen. Jeff Bingaman
625 Silver Ave. SW
Albuquerque, N.M. 87102

89 JUN 14 PM 1 57

JC DC 51883/4

Dear Sen. Bingaman!

Please include the following comments in the record for the Field Hearing of the Subcommittee on Minerals and Resources Development held in Albuquerque on May 25, 1989.

Federal air quality regulations should include:

1. For violations of clean air regulations which occur more than one time in three years or last for more than five days, the polluting source should be required to cease operation until the violation has been corrected.

2. To more accurately reflect reality, the name "Air Quality Permit" should be changed to "Air Quality Degradation Permit".

3. It should be required that all federal regulations must be met, but that states may enact and enforce more restrictive conditions in addition to federal standards.

4. Until a state has an EPA approved SIP the state may not issue any air quality

permits for new or expanded sources.

5. For areas in attainment, new sources should be limited to a maximum of 3% of the total allowable for any pollutant and expanding sources should be limited to 1.5% of the total allowable for any pollutant.

6. Where a zone change is required to allow a new source of pollution, the effective date of any air quality permit must be at least one day after the zone change is established and any appeals have been settled or the period allowed for appeals has expired.

7. Where an offset is required, the offset must be within one half mile of the pollution source for which the offset is required.

Credibility of air quality regulations and regulatory bodies is severly damaged by such instances as the following:

a. a state air quality bureau has never denied any application for an air quality permit

b. Testimony given under oath that the emission control equipment for a proposed source will be more than 99% efficient, a permit is requested for

- 3 -

June 5, 1989
Bingaman/Briscoe

18 Tons per year of emission, but the source is declared not to be a "major source". (If 18T/y = less than) 1% of the total, then 100% of the total = more than 1800T/y. - see 709 L 17 for definition of "major source")

c. where citizens were concerned about possible air pollution from the handling of production reject, the Engineering Project Manager testified under oath on Sept. 26 that "... we don't plan to make any reject... ... there will occasionally be a piece..." and a Project Engineer for the same company sends a letter to EID on Oct. 11 (15 days later) stating that "..... we expect to produce approximately 120 to 240 tons of waste gypsum product per week."

Thank you.

Phyllis Briscoe